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ENGINEERING BULLETIN

FOR THE INSTRUCTION *of* LUBRICATING SALESMEN

RUST PREVENTION

CONTENTS

SALES TECHNICAL SERVICE DEPARTMENT

STANDARD OIL COMPANY
(INDIANA)
CHICAGO

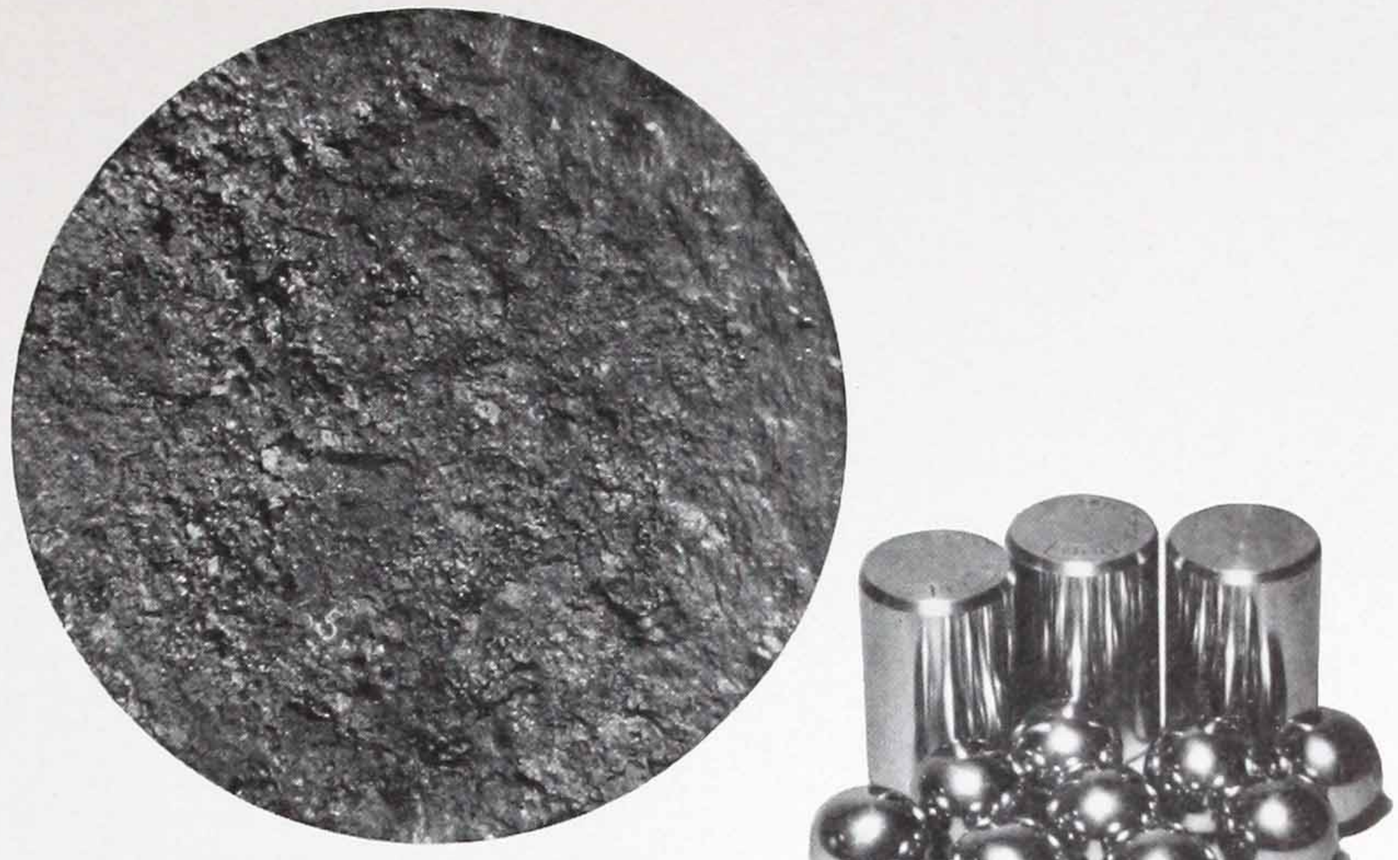

FIG. 1—(Circle) An enlarged view of a badly rusted steel surface showing the destructive action of industry's most constant and insidious menace. (Right) The protection of fine finishes like these demands a larger and wiser use of suitable rust preventives.

RUST PREVENTION

The special field of rust prevention with which this bulletin will deal is the protection of metal surfaces, usually ferrous metals, against corrosion by employing a coating or film (1) that is capable of being readily removed; (2) that will not impair the subsequent processing, operation, accuracy or sales appeal of the protected surfaces (even when not fully removed); and (3) that will provide a length and degree of protection in conformity with the prevailing service needs.

The following types of coatings are excluded by this definition of the subject:

1. Oxide coatings, phosphate coatings, heat bluings, etc.,—intended to give permanent protection.
2. Coatings of another metal such as zinc, tin, nickel, cadmium, chromium, etc.,—intended to give permanent protection.
3. Paints, varnishes, enamels, asphalts, etc., which produce dry, hard coatings—intended to give permanent protection. (Standard manufactures a complete line of asphalt products for this class of service.)

Included in the class of rust preventives with which this bulletin will deal are the products of petroleum derivation (excepting asphalt) which possess the necessary combination of properties to meet the requirements of such industries as:

1. Manufacturers or warehousers of anti-friction bearings (automotive, industrial, electric motor, etc.).

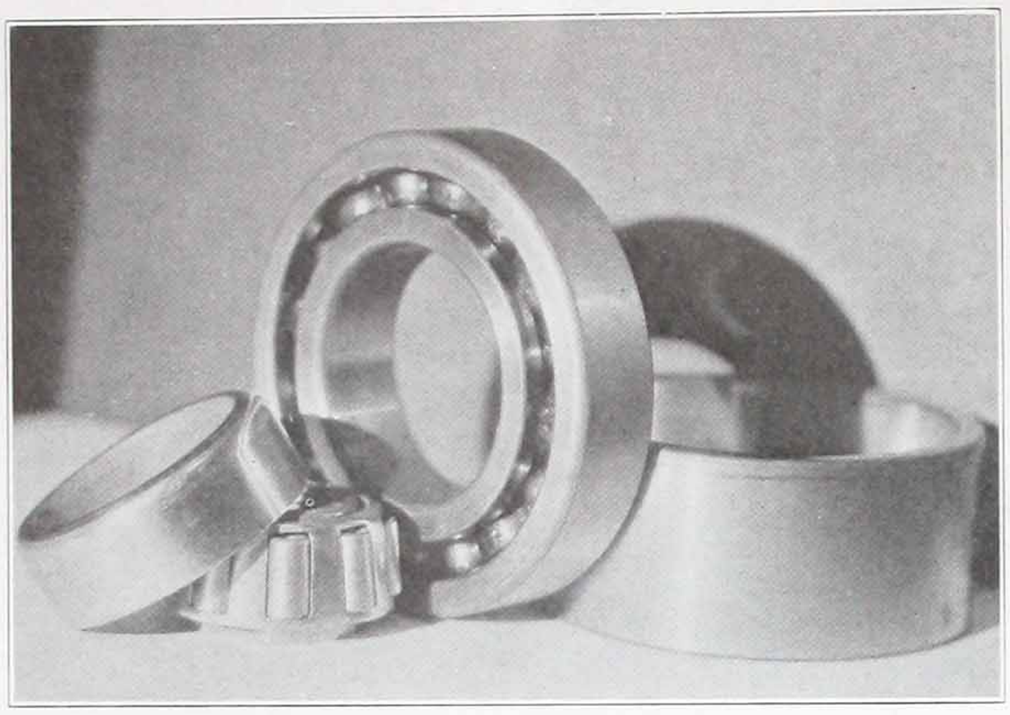

FIG. 2—Highly finished steel parts like those employed in ball and roller bearings must be completely protected against any trace of rust, and the rust preventive itself must not be detrimental to their operation.

2. Manufacturers or warehousers of automotive parts, refrigerating compressor parts, and similar equipment.
3. Manufacturers or warehousers of machine and hand tools, fire arms, military ordnance, precision instruments, etc.
4. Manufacturers or warehousers of steel sheets, strips, or bars requiring rust protection in storage or between processing steps.

For this particular field of service, some of the needs can be met by well chosen petroleum products of a conventional nature; for example, certain of the paraffine oils, engine and machine oils, heavy lubricating stocks, black oils, gear and cable compounds, lubricating greases, petrolatums, and so on. While such products may be satisfactory for some conditions of use, experience with them has shown that they are not capable of giving completely satisfactory results when the service conditions encountered are very severe. To secure really satisfactory rust protection under these conditions, newly developed, very especially compounded rust preventives are necessary. (Fig. 5.) The principal object of this bulletin is to explain why this is so.

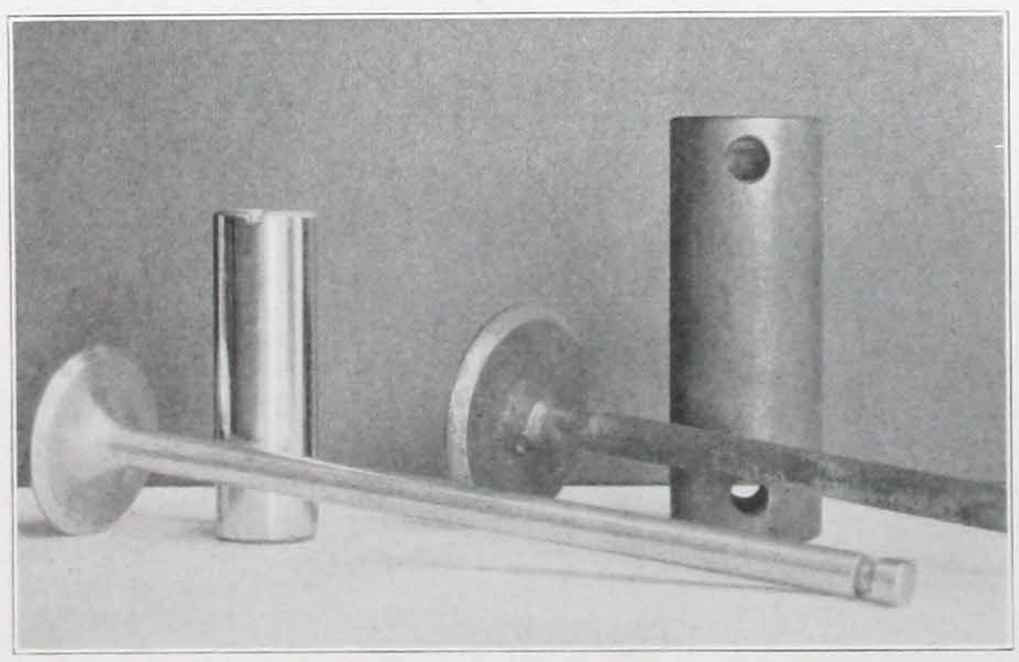

FIG. 3—A striking comparison which shows the value of adequate protection against rust. The parts on the right were given no protection during storage.

DEVELOPMENT OF PETROLEUM RUST PREVENTIVES

The development of petroleum rust preventives has grown out of a search for petroleum coatings which would meet the following particular needs:

1. Supply an adequate protective coating.
2. Not harden like paint or varnish.
3. Be sufficiently fluid to allow easy application either at normal temperatures or when heated.
4. Not crack, peel, or slip. (See Figs. 5 and 6.)
5. Be clean and easily removable.
6. Be a lubricant which can be left on frictional surfaces, eliminating the necessity of complete removal.
7. Be durable in effect and economical in application.

At first, ordinary lubricating oils, greases, and petrolatums were used, as has already been suggested. These were found to give protection nearly in proportion to their viscosity (for oils) or consistency (for greases or petrolatums). In other words, the most viscous oils and products of heaviest consistency gave the best protection, and the thinner products the least. The extremely heavy oils and lube stocks were usually dark in color, which was objectionable in many cases. In this respect the very adhesive stocks, derived as residual products from certain types of crude, gave good protection under severe conditions, but they were black and so sticky that they were very diffi-

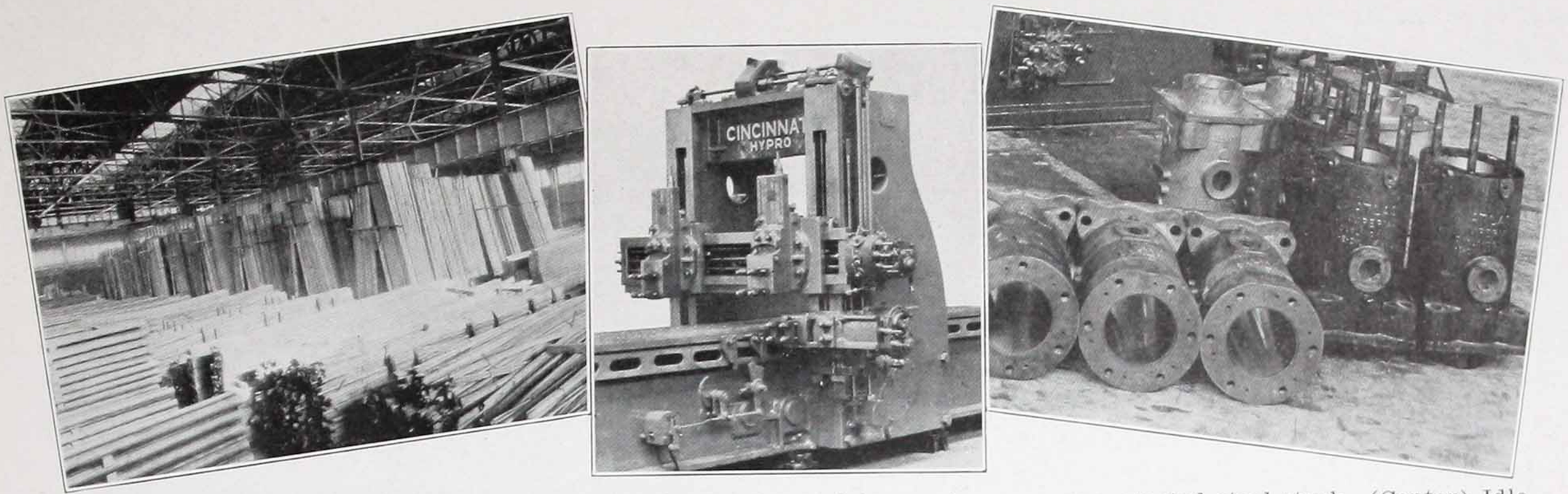

FIG. 4—(Left) Rust may exact a heavy toll in the raw materials warehouse on unprotected steel stock. (Center) Idle machinery and machinery in storage or shipment are quickly rendered inoperative or inaccurate by corrosion of highly finished surfaces. (Right) Finished parts or parts in process need protection to preserve the high degree of accuracy and precision which determines their operating efficiency and sales value.

cult to remove. Early experience seemed to indicate that where handling and storage conditions were not severe, plain mineral oils of varying viscosity and various grades of petrolatum gave satisfactory protection. Hence, such products are still used in a great many instances with a fair degree of satisfaction. Later, however, it was found that water vapor and air diffused through these films, and unless they were applied very thick, the protection given by them under particularly bad conditions was of doubtful value.

ADDITION OF SPECIAL INGREDIENTS

One of the first expedients tried in efforts to secure more complete rust protection was the addition of certain compounds to mineral oils and petrolatum for the purpose of increasing their resistance to the action of the moisture and oxygen of the air. Some of these compounds were found to have beneficial effects, but the disadvantages accompanying their use more than offset the ad-

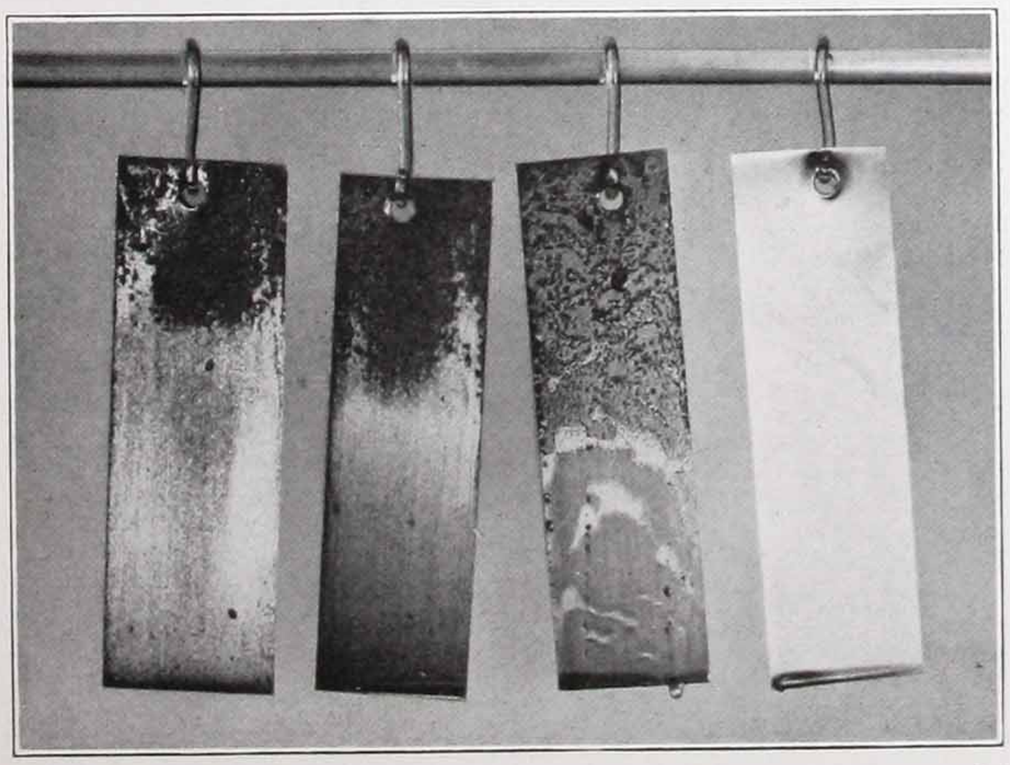

FIG. 5—Test pieces removed from a humidity cabinet; (1) with no protection, (2) protected only with a light-bodied mineral oil, (3) protected only with a petrolatum (note slippage), and (4) protected with Stanorust No. 4 (protection has been complete, the piece is still in its original condition).

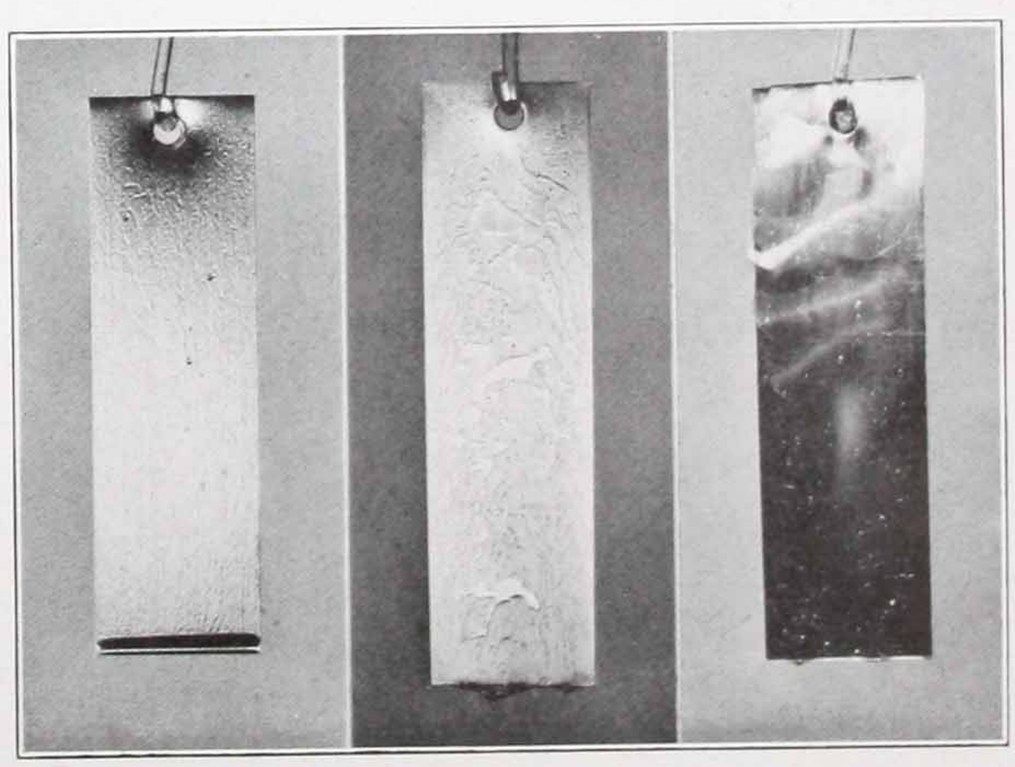

FIG. 6—Examples of (left) "checking," (center) "slippage," (right) "peeling." In each of these instances, the film of protective coating has failed to maintain complete coverage and rusting of the exposed portions will result.

vantages. For instance, a petroleum base mixture containing linseed oil, lard oil, and white lead gave a good protective coating under very adverse conditions, but such a film dried on the surface and was not a good lubricant. Furthermore, it was very expensive, and could not be applied in very thin films.

CHROMATES

In some of the technical literature on the subject of rust preventives, much has been said on the supposed advantages of incorporating in the product certain salts or pigments as rust inhibitors, particularly chromate salts of sodium and potassium. Although it has been held that the presence of these salts retarded corrosion tendencies, the idea that they actually have this supposed protective action in rust preventive compounds is open to serious doubt. Furthermore, they are limited to applications which can be made at normal temperature or with only moderate heating, since too much heat might destroy the emulsion and cause separation.

This limitation in the use of chromates is due to the fact that chromates are water soluble but not oil soluble. They depend on water incorporated in the product formula, as in an emulsion, to maintain their solubility. Evaporation of the water as a consequence of much heating is, therefore, likely to result in separation.

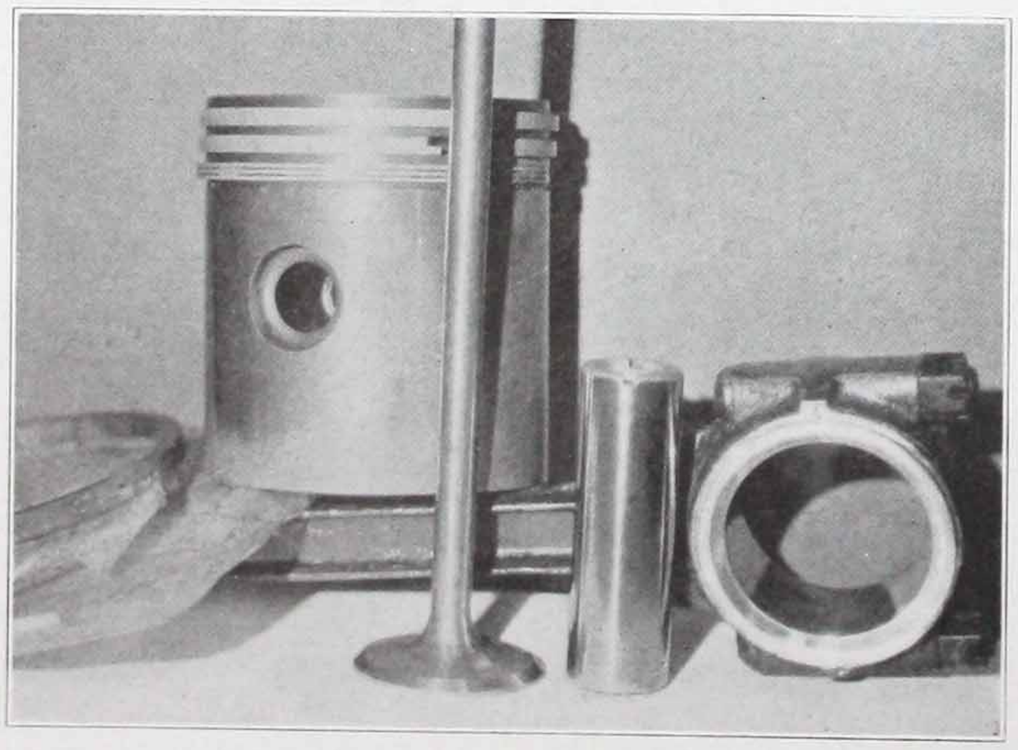

FIG. 7—Pistons, piston rings, valves, wrist pins and connecting rods in temporary or regular storage are typical of a large classification of automotive products needing the kind of protection supplied by petroleum-derived rust preventives.

NEWLY DEVELOPED INGREDIENTS

Chromates are still used in some petroleum rust preventives, mostly to satisfy an old specification of doubtful value, but the search for superior ingredients has continued. Subsequently, other types of ingredients were developed which greatly increased the rust prevention properties of the product. Petroleum rust preventives especially prepared with these newly developed ingredients have been found to more completely satisfy the conditions of service and at the same time possess none of the former disadvantages.

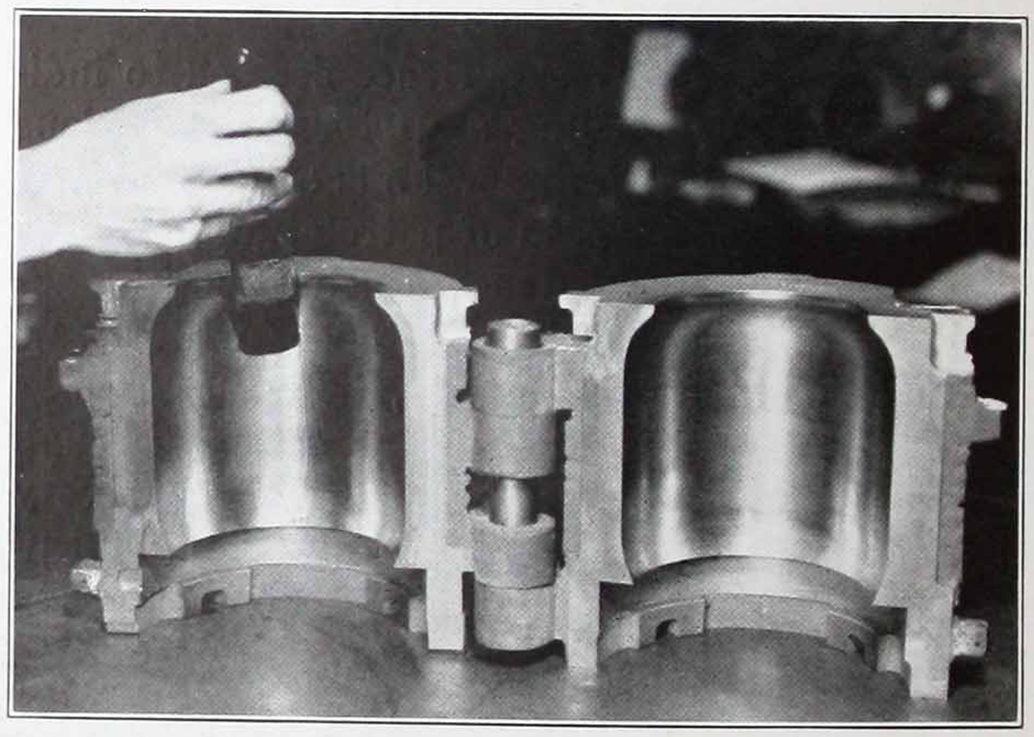

FIG. 8—Stanorust No. 3 protects these bottle molds while in storage better than a mineral cylinder oil formerly used, saving half of the oil originally required and eliminating a washing operation before being put back in use because it wipes off readily.

SUITABILITIES OF VARIOUS TYPES OF RUST PREVENTIVES

There are many different types of petroleum rust preventives, but in general, from the standpoint of appearance and handling, they may be divided into three classes, namely, (1) fluid types, (2) semi-fluid types, and (3) semi-solid and solid types.

FLUID TYPES

Articles which are not subjected to severe exposure, such as small machined parts standing indoors and not exposed to moisture other than

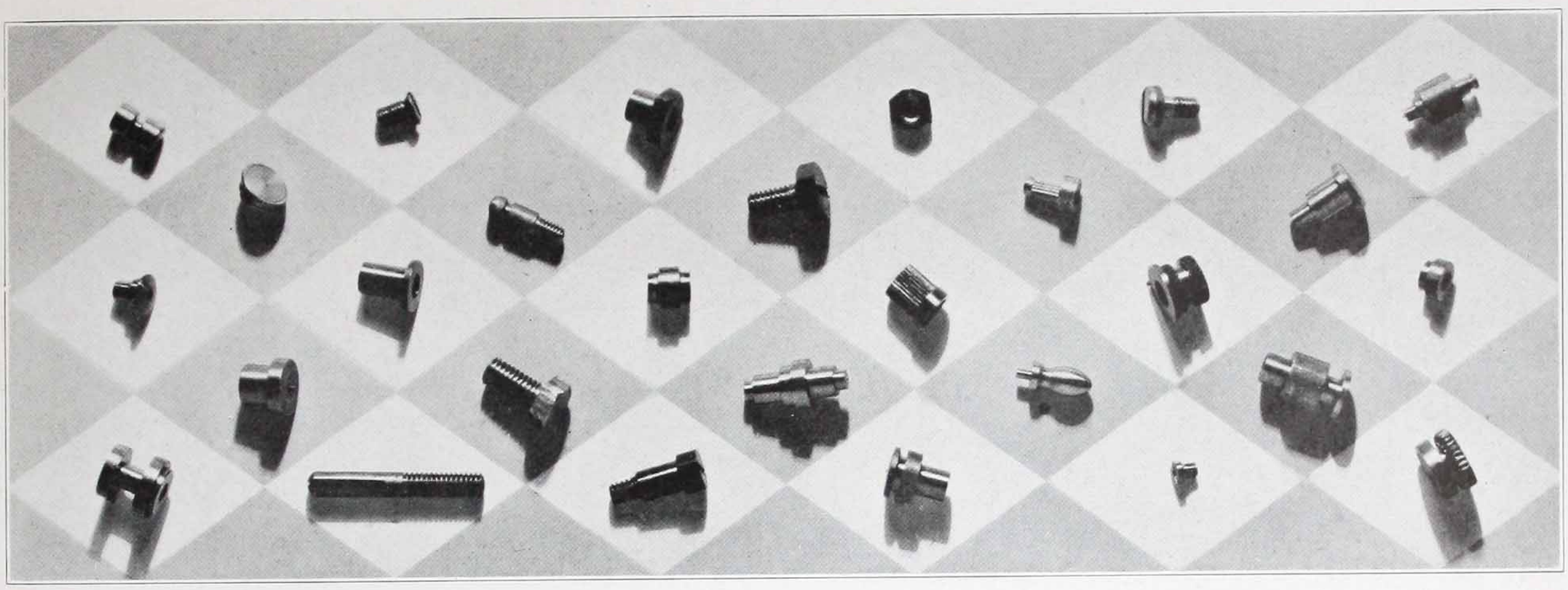

FIG. 9—Many kinds of small parts which are subject to rusting at any stage of their manufacture, use, or storage can be kept in perfect condition, free of tarnish and rust spots by properly selected rust preventives. Parts which are subjected to much handling should also be wrapped in oiled paper.
Courtesy, Brown & Sharpe Mfg. Co.

the normal humidity of the atmosphere, may be satisfactorily protected with a very fluid type of product. The main disadvantage of this type is the low viscosity (light body) which permits the product to drain from the coated parts, leaving practically no protecting film except where it still clings to the under side. Dust and dirt falling on the films left by such light-bodied products tend to absorb them and leave the surfaces with little or no protection against moisture and air. Furthermore, if the parts are handled, a light rust preventive is easily rubbed off. It is evident, of course, that even the best quality of such light-bodied rust preventives if used under these adverse conditions, cannot give satisfactory service. Hence, when objects are likely to be exposed to a great deal of dust and dirt, and are apt to come in contact with moisture, a heavier-bodied rust preventive is really required. Such materials provide thicker coatings which are not likely to be absorbed by the dust or rubbed off as readily. A scientifically prepared light-bodied product will, however, give good protection to parts wrapped in waxed or oiled paper (Fig. 10) and will also give good protection for short periods of time to parts in the process of manufacture and spare parts in temporary storage.

SEMI-FLUID TYPES

Semi-fluid types of rust preventives are able to give much better protection than the fluid types. They still possess the same disadvantages; although to a lesser degree.

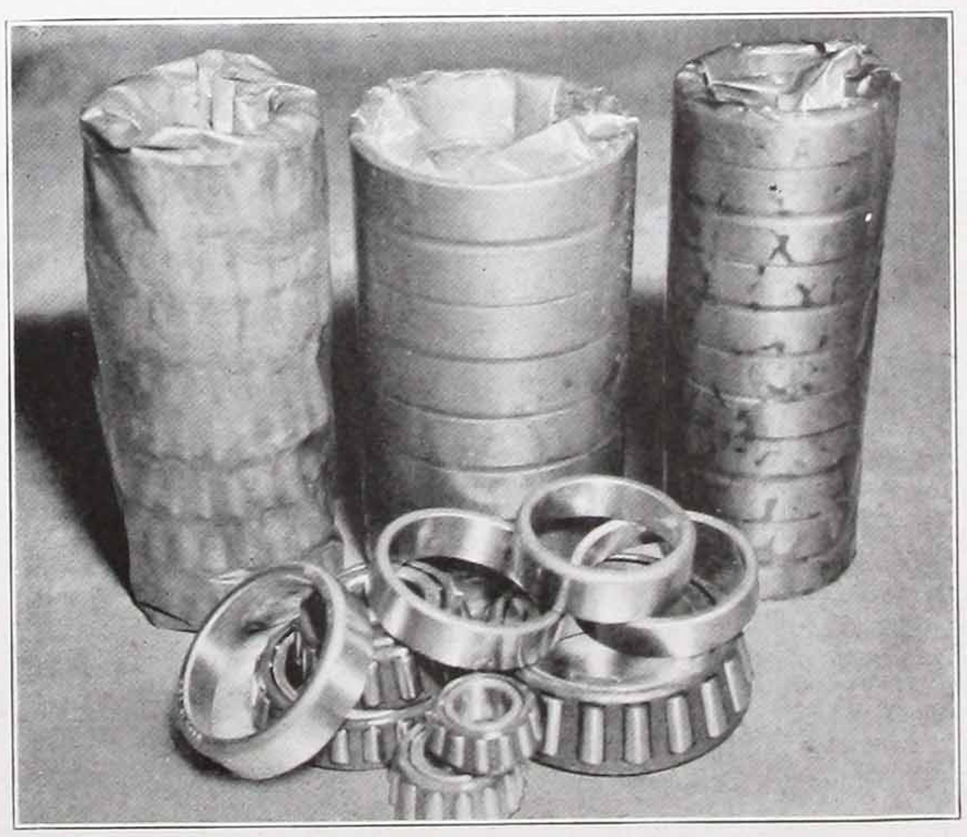

FIG. 10—Roller bearing parts and the manner in which they are wrapped in oiled paper to insure complete protection during subsequent handling and storage after application of the rust preventive.
Courtesy, International Harvester Co.

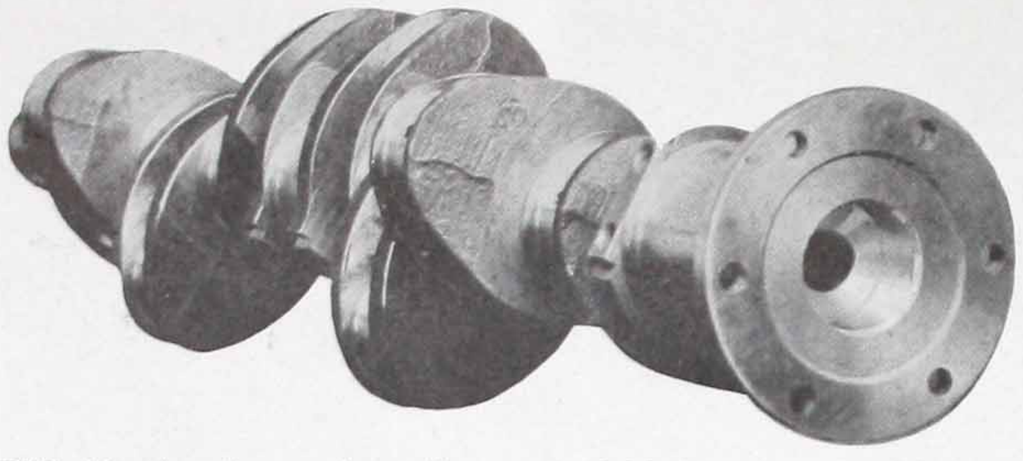

FIG. 11—Another automotive part of high cost and with precision crank pin and journal surfaces is the crankshaft. In process or storage or shipment, a suitable rust preventive on the frictional surfaces is necessary.

SEMI-SOLID AND SOLID TYPES

The semi-solid and solid types of rust preventives are used when protection is to be afforded under the most severe conditions, such as outdoor storage in all kinds of weather, or where the object is exposed to chemical fumes, brine, or other highly corrosive substances. These products, furthermore, are more desirable for protection when storage is to extend over a long period of time, as they will not drain from the surfaces, are less absorbed by dust and dirt, and are less readily removed by handling or other mechanical action.

PROPER SELECTION OF TYPES

Rust protection with any of these various products will largely depend upon the proper selection of product for the exact nature of the conditions of service. Incorrectly selected products are likely to be blamed for rusting troubles, when more thorough investigation would show, for example, that higher humidity and dampness than was anticipated had been experienced, or some change in shop practice had been made, which was responsible for the failure to adequately protect against rusting. So many variables like this can be encountered in modern production and handling methods that a most thorough and careful study is necessary to fit a rust preventive product to a particular job.

When the conditions have been fully investigated, it is then necessary to base the selection of product on the worst conditions which are likely to be encountered. This must take into account the manner and time of storage before the protected object is shipped to the distributor or consumer, how and where shipment is made, and, finally, the storage conditions at the customer's plant before the product is put in use. It is particularly important to know if the atmospheric conditions of storage are, for example, "hot and dry" or "cold and damp." If storage is outdoors, the climatic conditions must be considered, and in all cases the length of time the object is to remain in storage must be estimated. Objects may be wrapped or packed and thus protected from dust and direct action of moisture. Allowance may then need to be made for the tendency of the wrapping or packing material to absorb the rust preventive, thereby reducing its protective properties. Absorption of the rust preventive by the package or container

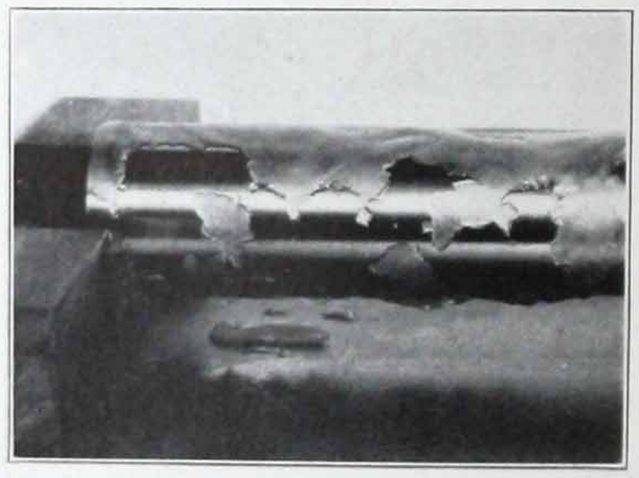

FIG. 12—An example of "slippage" and "run-off" on a steel rod.

may result in unsightly and undesirable appearance and this must be taken into account. The method best suited for the application of the product selected must then be decided upon in relation to the extent or degree of protection required.

CONSIDERING LIMITATIONS OF PRODUCTS ALREADY IN USE

In making a choice of rust preventives to give improvement over products already in use, there are several factors that should be taken into consideration. Investigation should be made of the degree of satisfaction the product in use is giving compared with the results which may be expected from the recommended product and method of application. The following queries should be made:

a. Is sufficient protection being given at present to resist the atmospheric temperature and other conditions of exposure for the necessary length of time?

b. Is an excessive amount being used for the protection required?

c. Can the method of application with the new product be simplified or improved?

d. Will the new product give better protection at the same or a reduced cost, or the same protection at a saving?

e. Is the compound in use difficult to remove?

f. Is it a lubricant, or will it dry and gum?

g. Is the color important?

h. Does the present product drip from the object onto the shelves when in storage?

i. Will dust absorb the present rust preventive and thereby remove the protecting film?

From the above it is evident that a great deal of thought must be given to a problem of this kind. A wrong recommendation may mean the waste of material or inferior protection, both of which can be avoided by careful analysis of conditions beforehand.

FIG. 13—Application of rust preventive by dipping gives complete coverage and the excess material is drained back into the dipping tank. Heavier-bodied rust preventives are usually heated to give more economical coverage in thin films and to speed up the time required for draining.

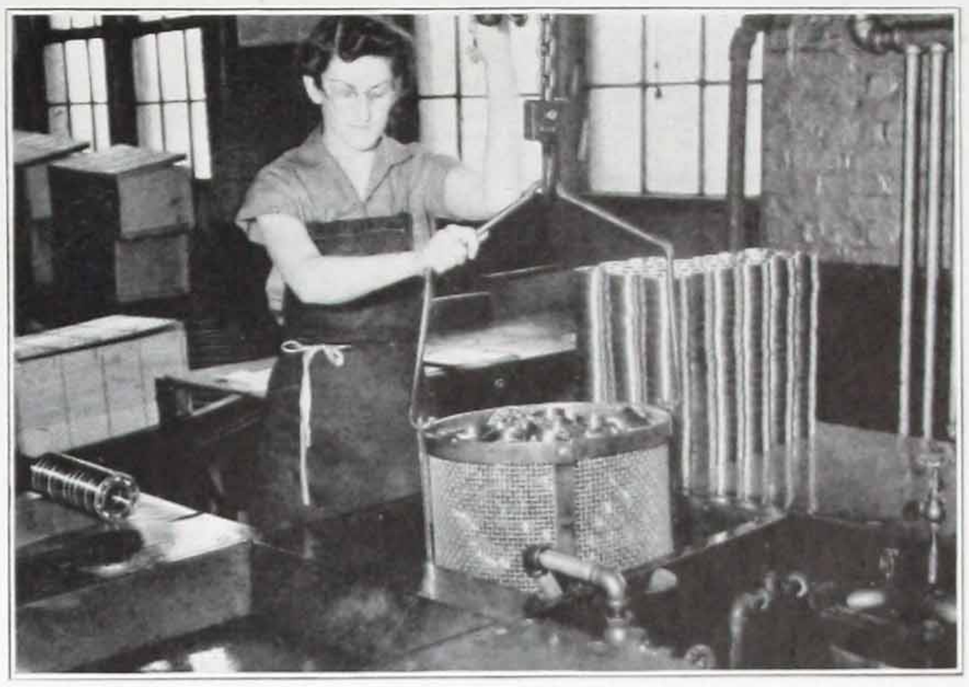

FIG. 14—Dipping of ball bearings in a hot bath of melted rust preventive prior to wrapping in oiled paper. Courtesy, International Harvester Co.

METHODS OF APPLICATION

The three general methods of applying rust preventives are:

Dipping—Spraying—Swabbing

DIPPING

Dipping (Figs. 13, 14, and 31) has many advantages over spraying or swabbing, and wherever the size of the object permits and the equipment is available, this method of application as a rule will give the most satisfactory results both as to minimum of labor and of compound required. For dipping purposes it is necessary to have a dipping tank, baskets or hooks to hold the parts while being dipped, a hoist for lowering and raising the baskets or hooks, and a tray over which the dipped parts may drain. The trays are inclined so that as the rust preventive drains from the parts, it is returned to the tank. Oils may be heated if desired, but semi-solid or solid products must be heated to a liquid state for application by dipping. A sufficient quantity of rust preventive should be used in the tank to avoid excessive chilling of the compound when dipping cold metal parts. The parts must be held in the hot rust preventive till they reach a temperature high enough to permit the excess rust preventive to drain off and leave only the necessary thin film for protection.

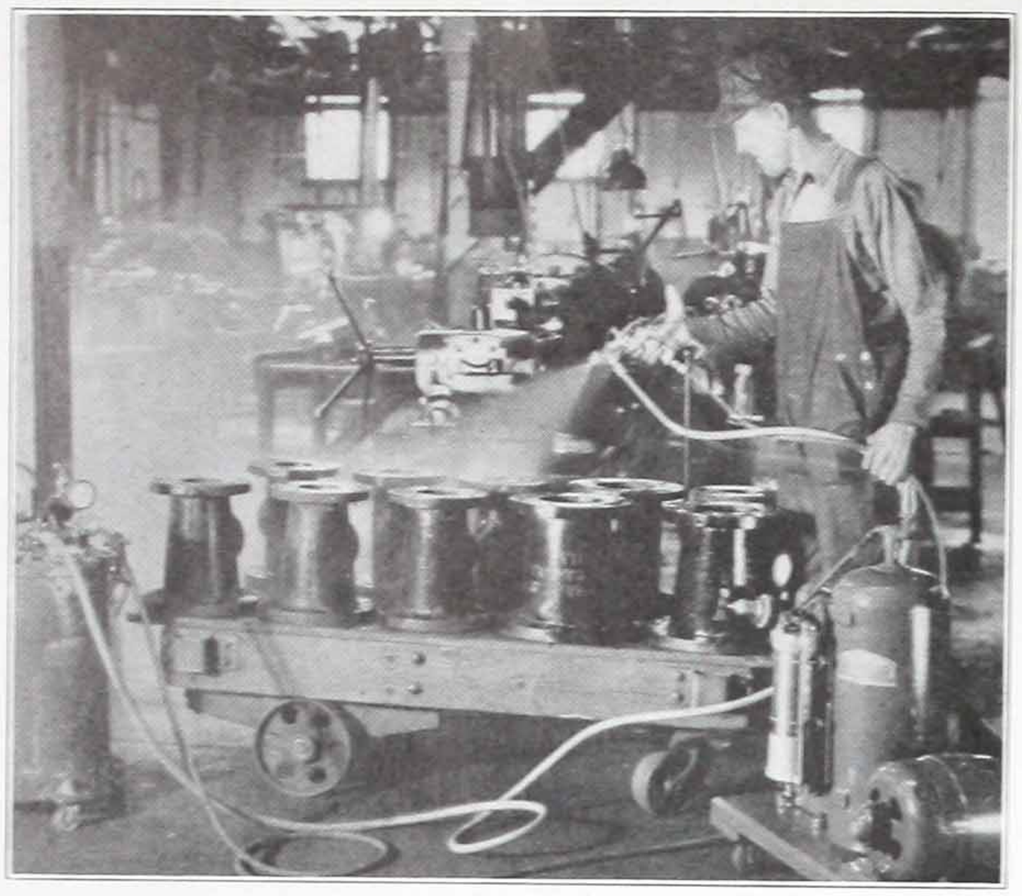

FIG. 15—The growing use of spray equipment for application of rust preventives makes it necessary to provide suitable grades for this means of application without sacrifice of good rust protection qualities.
Courtesy, Binks Mfg. Co.

Petroleum compounded rust preventives are very stable, and with the exception of those containing a volatile thinner, the heavier grades may be safely heated to temperatures well above their melting point without danger of separating, gumming or foaming. It is not necessary to exercise great care in the heating process, and any method of heating may be employed, providing the usual precaution in heating petroleum products is observed. Where drainage of the excess product from the parts proceeds too slowly, the temperature of the bath should be raised.

SPRAYING

Spraying (Figs. 15 and 16) is generally restricted to the use of oils or light-bodied products, because of the difficulties of stoppage encountered with the chilling of melted products in the spraying equipment, especially in the feed lines and nozzles when spraying is done intermittently. The heavier-bodied products may be used if they are soft enough, or thinned sufficiently with a volatile carrier, or kept fluid with heat (Fig. 19.) Ordinarily, it is not recommended that heat be used for spray application unless special precaution against fire hazards can be observed. One objection to the use, in spray equipment, of products thinned with a volatile carrier, is that the carrier will evaporate from the product in the nozzle when the apparatus is not in use, causing the passages to become clogged.

An increasing use of spray equipment for the economical application of rust preventives has brought about a great need for products sufficiently fluid at room temperatures to be sprayed in thin films, and at the same time offering a more durable long-time protection than ordinary petroleum oils. To meet this particular need, new fluid-types of rust preventives have been developed. One of the heavier-bodied, fluid-types of these new preventives can be used for spraying if temperatures are not below 60° F. At lower temperatures the lighter grades must be used.

Usually any standard spraying equipment will give good results; however, the equipment selected should give good atomization, without slugging, for most economical and satisfactory application. For properly handling the semi-fluid grades, the spray equipment should be of a type that can apply an independently adjustable air pressure over the rust preventive product in the tank and to the spray nozzle as well.

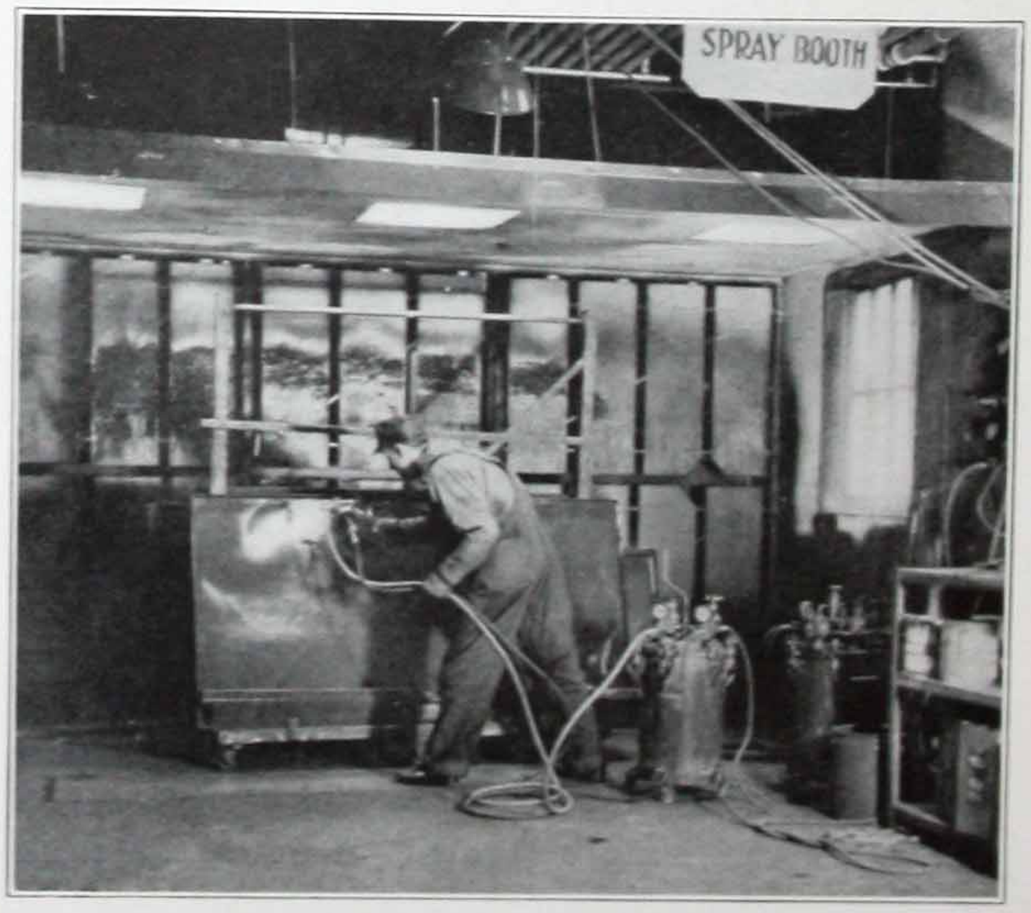

FIG. 16—Rust protection of steel panels between finishing processes is provided by a sprayed application of rust preventive.
Courtesy, Binks Mfg. Co.

SWABBING

Swabbing (Figs. 17 and 18) is the simplest method of application, and is about the only method available for covering certain pieces of equipment. For instance, large pieces of machinery which require protection against severe exposures, such as may be encountered in foreign shipment, must be coated with a semi-solid product. A naphtha thinned product of this nature is especially suited to this purpose as it can be applied in very thin films with little labor. Products which are stiff at ordinary temperatures may be swabbed on metal surfaces after they have been melted. It is difficult, however, to obtain thin and uniform films as molten products chill when they strike cold metal surfaces and are very difficult to spread. Soft products can be smeared on cold, but not so economically as when heated first to permit application in thin films.

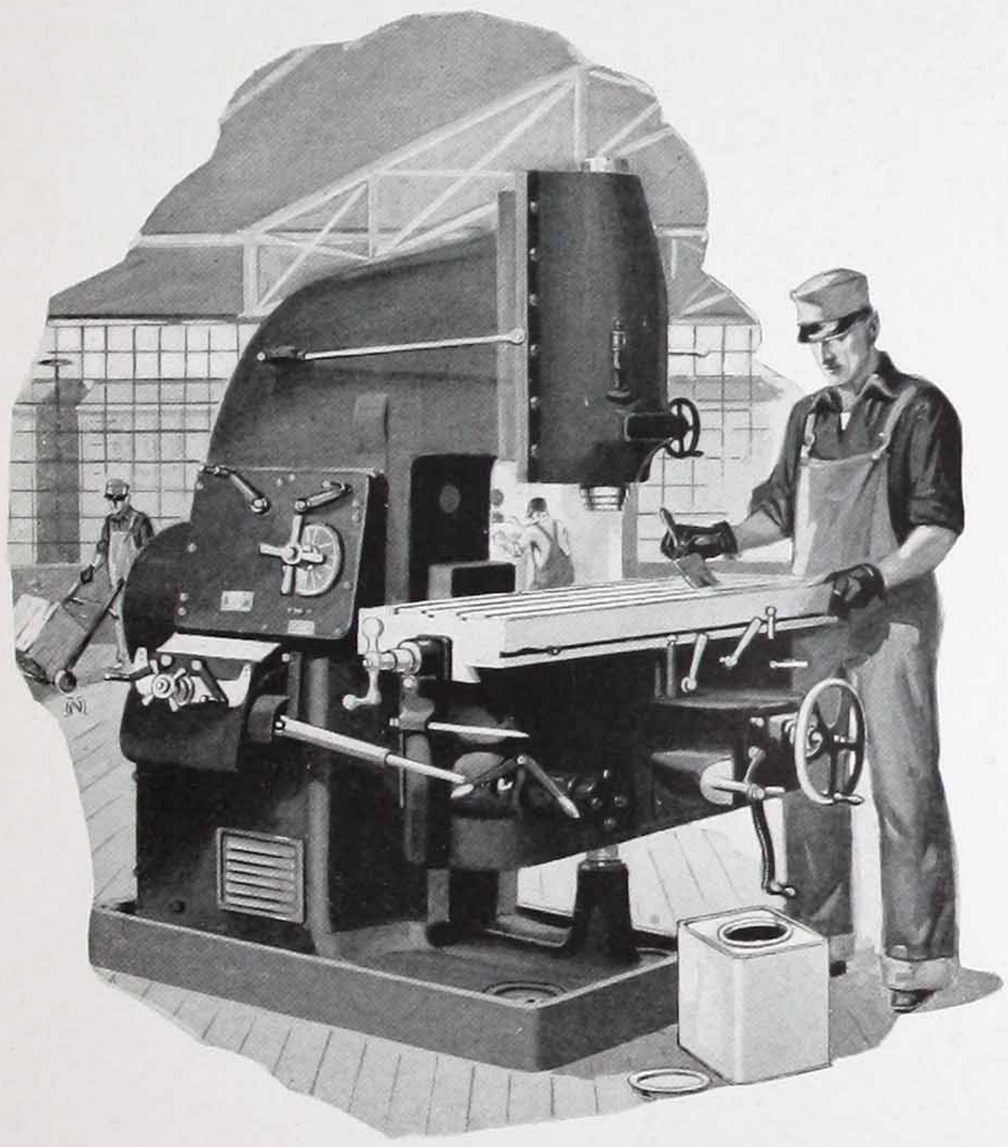

FIG. 17—A bulky machine or piece of equipment does not lend itself to a hot application of melted rust preventive and yet maximum protection is often necessary. For such conditions, a practically solid rust preventive, which has been thinned to a soft consistency with a volatile carrier, is ideally suited because it permits cold application in thin films, by either swabbing or brushing, and in a few hours the volatile carrier evaporates, leaving a tough, impervious film of rust preventive.

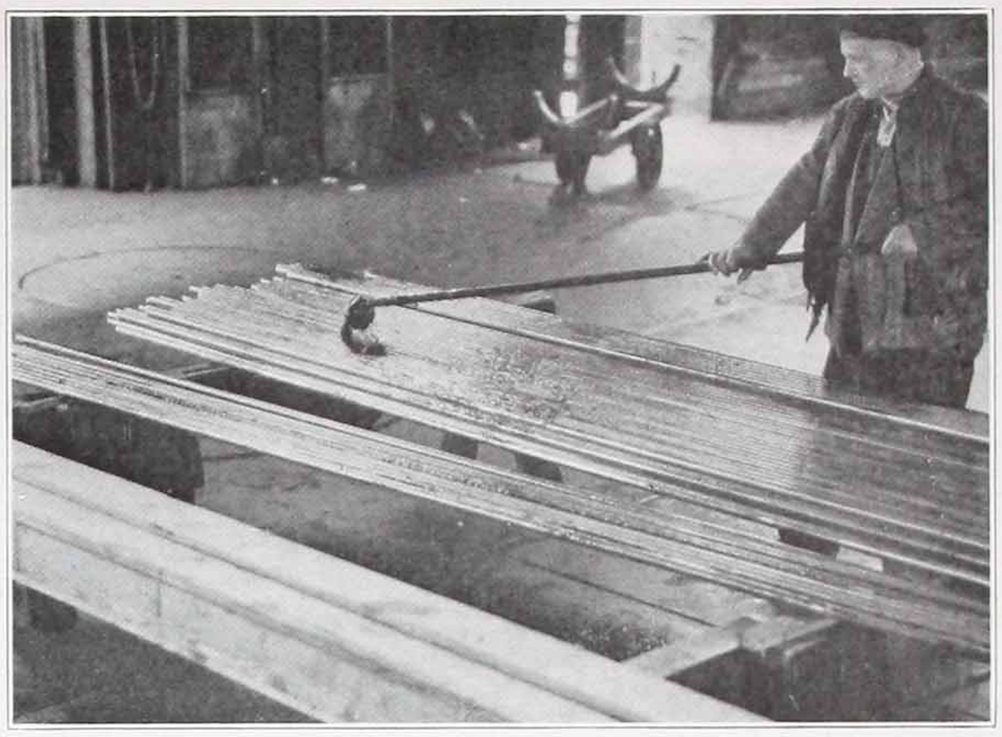

FIG. 18—Unwieldy pieces, requiring a very heavy-bodied rust preventive for maximum protection, are generally swabbed. Greater economy and better film penetration is secured when the rust preventive is applied hot.

Oils and similar light-bodied rust preventives, of course, can be applied very easily, and, where protection against severe conditions is not required, they are better adapted for swabbing than the heavier-bodied products.

Decided advantages are derived in a majority of cases when the rust preventive is heated before application. Greater coverage per gallon of the compound used is obtained, and a uniform film penetrating into the crevices and pores of the metal surface is assured.

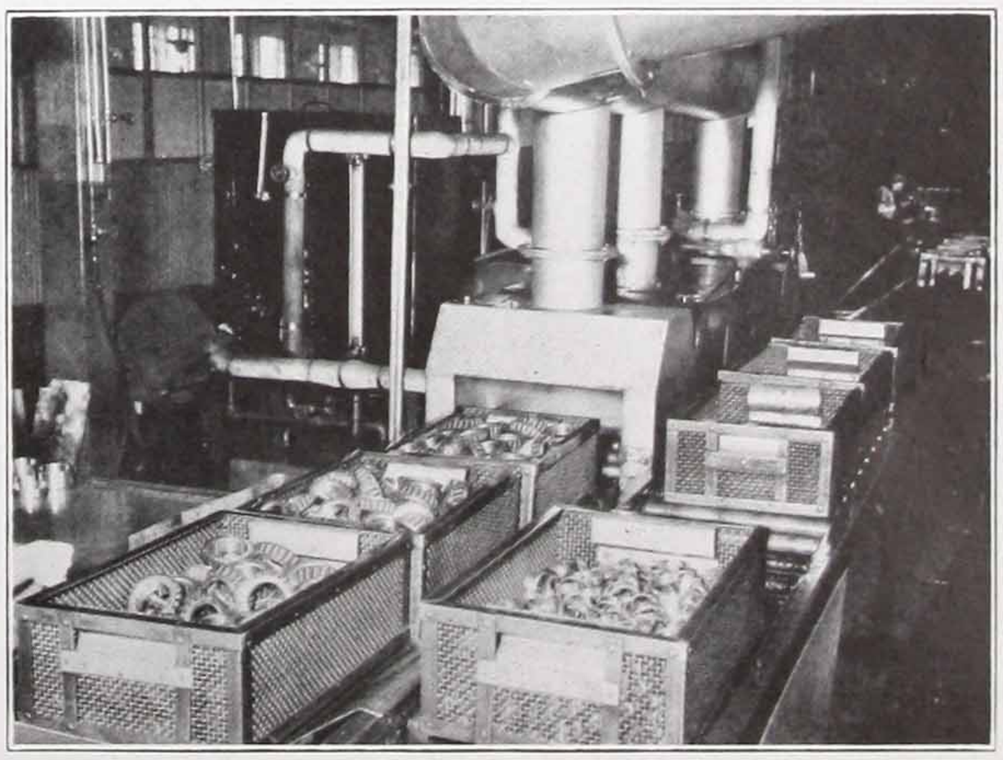

FIG. 19—Molten rust preventive is sprayed on these roller bearings as they pass through this continuous oven conveyor, after which they are wrapped in oiled paper.
Courtesy, International Harvester Co.

MODIFICATION OF METHODS

There are many modifications of the dipping, spraying, and swabbing methods which are suited only for very specific cases. It is necessary, therefore, to give careful thought to each case, and possibly to devise some new methods of application which are better suited for the conditions. Some of the modifications of the three general methods of application are:

a. Spraying a rust preventive on parts which are moving on a conveyor (Fig. 19).

b. Spraying a rust preventive on flat sheets or strips as they pass through processing rolls.

c. Circulating spray system, which collects the drainings, and uses them over again.

d. Passing parts, usually flat materials, between felt rolls saturated with a rust preventive.

e. Rolling circular or round objects through a shallow bath or on a saturated felt.

f. Tumbling parts in barrels or boxes containing waste saturated with the rust preventive.

g. Sprinkling small parts, which are heaped up in a pile, with a rust preventive, then turning over with a shovel.

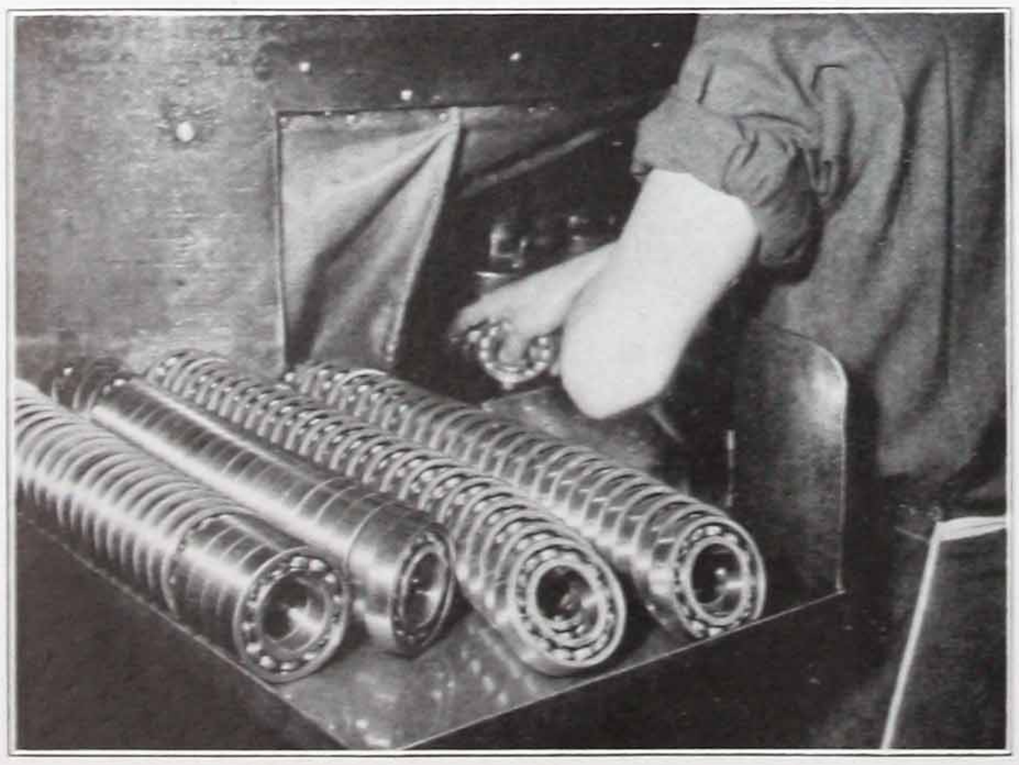

FIG. 20—Before dipping these ball bearings in a rust preventive, they are flushed clean with hot mineral seal oil in this washer. Illustrating a practice based upon recognition of the importance of a clean, moisture-free surface before applying the rust preventive.
Courtesy, International Harvester Co.

IMPORTANCE OF DRY, CLEAN SURFACE BEFORE APPLICATION OF RUST PREVENTIVE

Irrespective of the method of application, it must be borne in mind that before applying any rust preventive, surfaces should always be dried (i.e. free of moisture) and cleaned (Fig. 20), and it is very important that all traces of rust be removed. Rust left on surfaces forms a nucleus about which more rust may form even when protected with a coating of the best rust preventive. After grinding and drawing operations it is essential that the fluid used in the operation be removed; otherwise, the rust preventive will slough off and leave the surface without sufficient protection, whereupon corrosion difficulties are likely to be encountered.

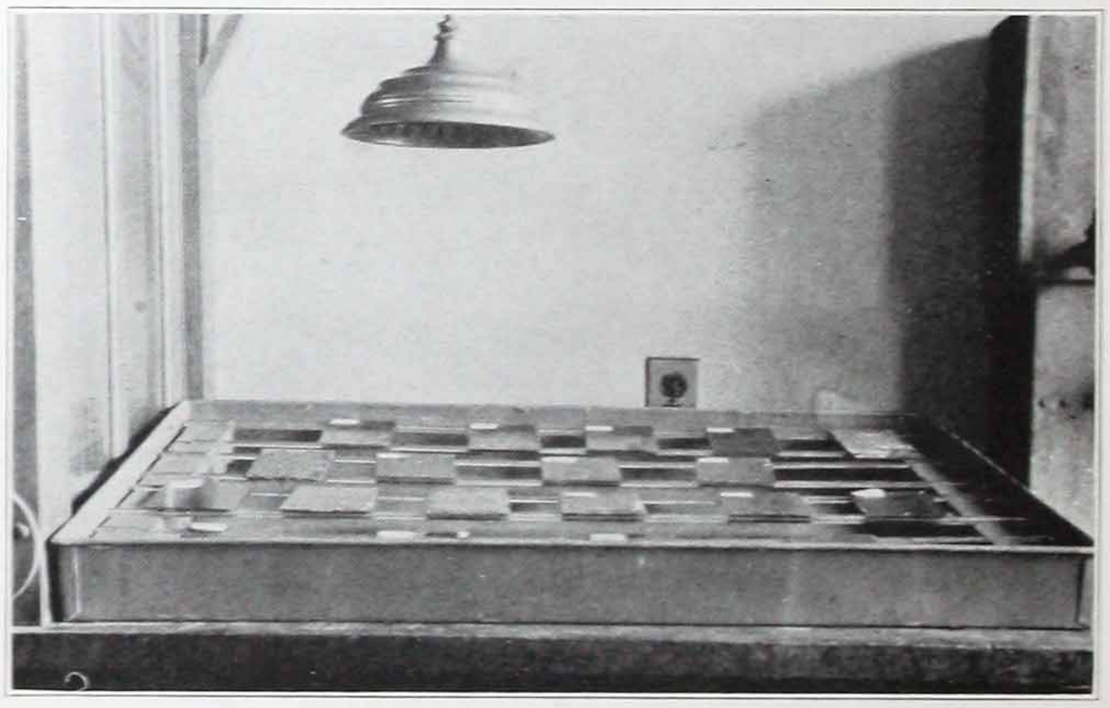

FIG. 21—Spray test on steel plates to determine the effectiveness of various rust preventives.

TEST METHODS EMPLOYED TO EVALUATE RUST PREVENTIVES

In order to shorten the time necessary for evaluating the protective properties of different rust preventives, accelerated tests that can be conducted in a laboratory have been devised. The test results must, of course, correlate with actual practice.

In the latter connection, it should also be kept in mind that a rust preventive designed to give pro-

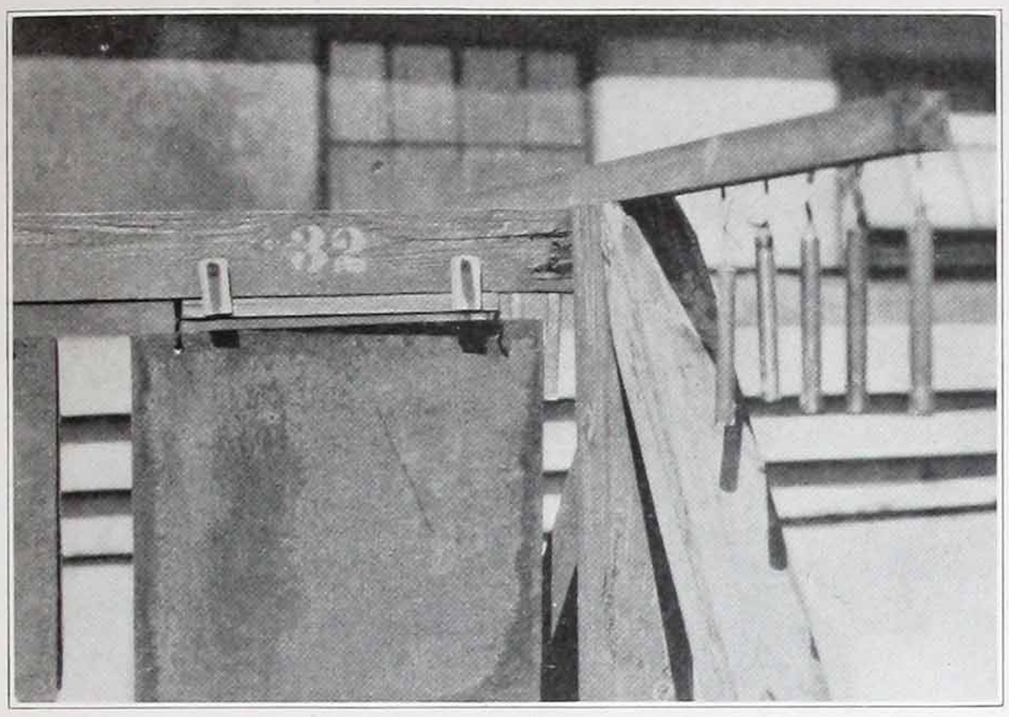

FIG. 22—Exposure tests to determine the efficiency of various rust preventives in the search for improved products.

tection against moderate conditions should be given a correspondingly moderate test. It is not necessary, nor should it be expected, that an oil used for the protection of automobile parts stored inside while awaiting assembly, should give protection against severe outside storage conditions. Although oils and extremely light-bodied products can resist the action of moisture, they are not able, because of their low viscosities, to withstand the washing and beating action of rain and the absorbing action of dust. Tests should be conducted on a basis comparable to the most severe conditions actually to be encountered and comparable to the actual period of protection required.

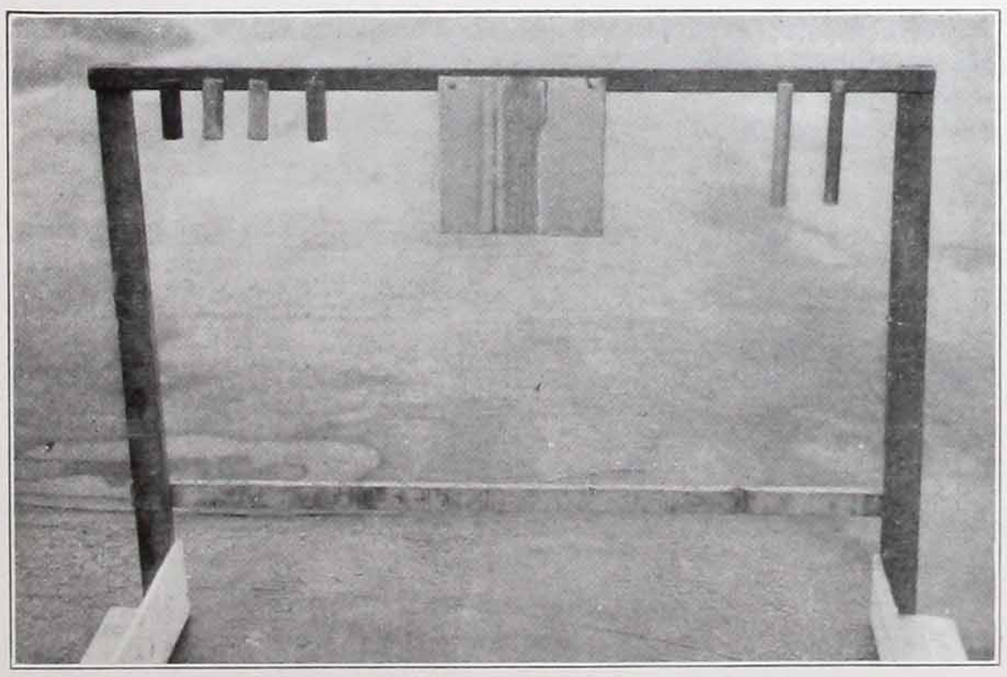

FIG. 23—Outside exposure tests under way on the roof of the testing laboratory.

SALT SPRAY TEST

One of the tests often used, is the Salt Spray Test, wherein a coated plate is kept in a horizontal position and lightly sprayed with a 3 percent salt solution once every day for a period of 5 days, after which no corrosion shall be evident.

WATER SPRAY TEST

Oftentimes a plain water spray test is run which consists in placing plates under an intermittent shower, a vigorous shower being applied for approximately three or four minutes, then no water for the same length of time. The shower may be formed by allowing water to siphon at intervals from a five gallon tank into a metal trough, the bottom of which is perforated with three or four rows of holes (about $\frac{1}{16}$ inch in diameter). The water shall fall about two feet to the plates, which are held at about a 30° angle directly under the falling water. At the end of five hours of this intermittent showering, the plates shall be placed in a horizontal position and allowed to remain with any adhering water for at least 24 hours. No rust shall be in evidence on the plates after the completion of the test, and the coating on all plates shall be easily removed with waste wet with kerosene.

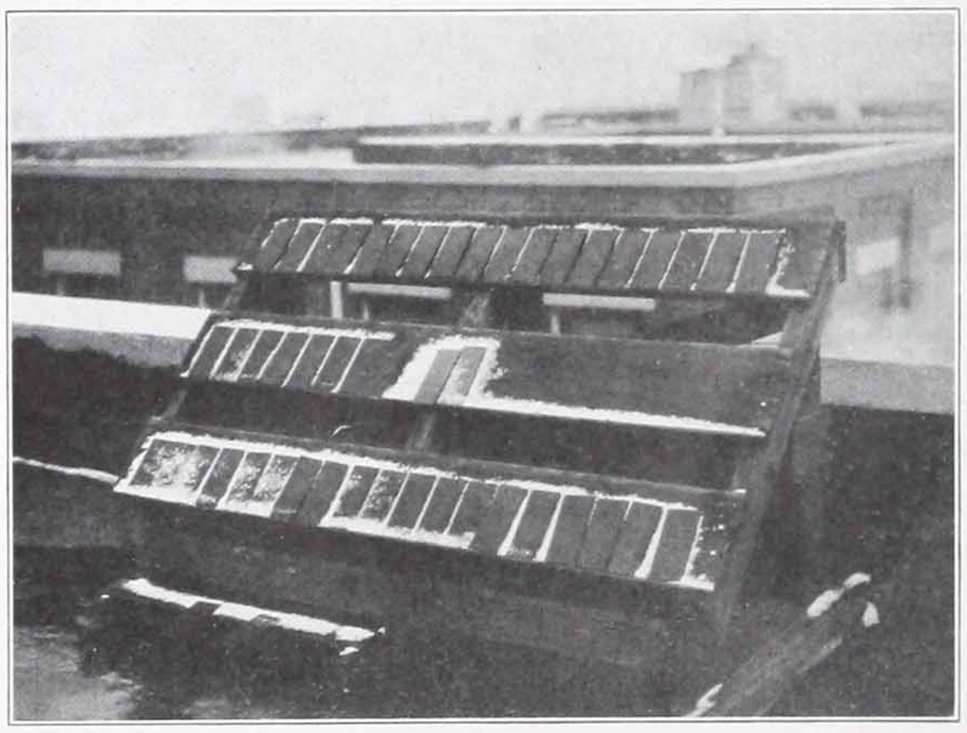

FIG. 24—An outside exposure test rack tilted to secure direct rays of the sun at midday.

MISCELLANEOUS REQUIREMENTS

Besides the above described tests there may be any number devised to evaluate a rust preventive for a special or particular job. In addition to the usual corrosion and adhesion tests run, it is common practice in many instances to include in the specifications limitations on abrasiveness, acidity, stability, and "non-drying" characteristics.

EXPOSURE AND HUMIDITY TESTS

Of all of the tests devised, perhaps the exposure tests (Figs. 22 and 23) or humidity tests (Figs. 25 and 26) are the most important of all, since almost any rust preventive used may at some time be exposed to the weather, or to widely and rapidly changing temperature conditions. Therefore, it is essential that the rust preventive give an impervious and lasting film, even when subjected to rapidly changing temperature conditions, and even, in some cases, to the direct action of rain, snow, dust, etc.

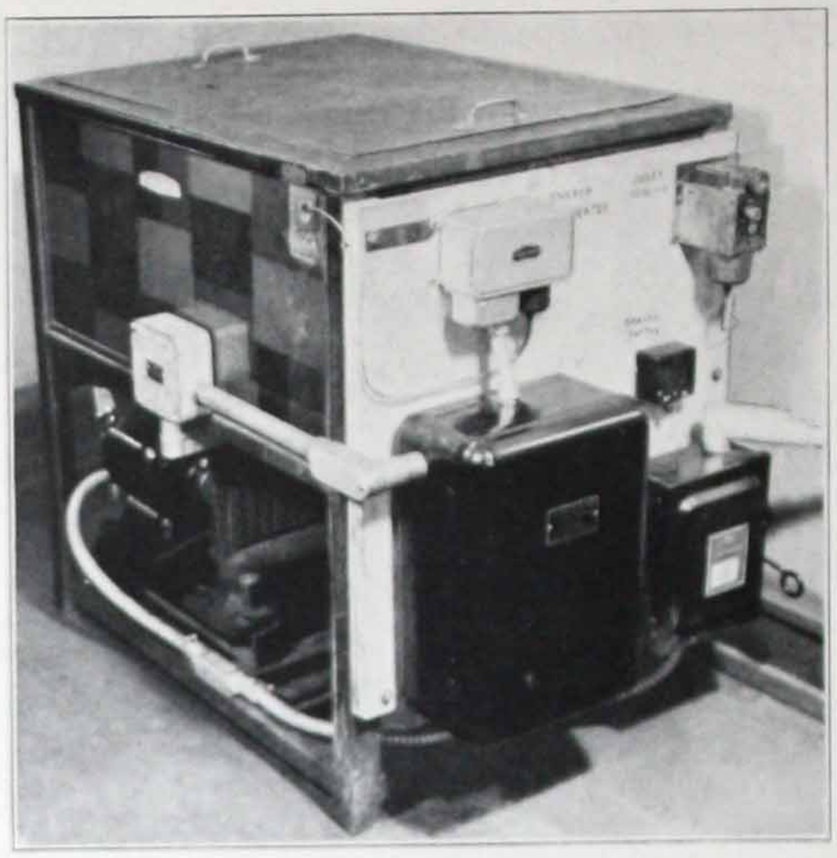

FIG. 25—Humidity cabinet with controls for the heating and cooling elements. A refrigerating compressor is located below. This apparatus is used to test the effectiveness of rust preventives under carefully controlled adverse conditions.

GENERAL PRINCIPLES OF CORROSION

CORROSION A CHEMICAL ACTION

Corrosion may be broadly defined as the chemical action of certain external agencies on metals which causes their deterioration or destruction. In general, this is an oxidizing process by which oxygen from air or water, or both, reacts with the metal to form rust. Other types of corrosion also occur when there are present in the atmosphere such impurities as sulfuric and carbonic acids from smoke and industrial processes or salt mist from the ocean.

INFLUENCE OF AIR AND WATER

The combined action of air and water is responsible for the greater percentage of corrosion troubles, and dissolved oxygen is essential if appreciable corrosion is to take place in water. Further, dry air, by itself, will not cause corrosion of metal at normal temperatures, but at elevated temperatures will show some effect. Corrosion is also more rapid in acid or alkaline solutions than neutral solutions.

DEW POINT TEMPERATURE AS AN INDEX

The relative humidity of the atmosphere is usually regarded as the principal index of corrosion dangers. A more important index probably is the dew point temperature. Dew point is the temperature at which saturation of the air with moisture occurs and condensation of the invisible water vapor begins. Even when the moisture in the air is below the saturation point, corrosion can occur from an absorbed film of moisture on the metal surface despite the fact that no moisture is visible.

DISSOLVED OXYGEN IN MOISTURE

Assuming the presence of moisture, the principal instigator of corrosion is the dissolved oxygen in this moisture. Any moisture from the atmosphere is naturally saturated with oxygen as well as corrosive chemical impurities which may be present in such atmosphere. From this it can readily be seen that any steps which can be taken to prevent the condensation of moisture on the metal surface would go far toward the elimination of corrosion.

ELECTROCHEMICAL THEORY OF CORROSION

The electrochemical theory is now generally accepted as the most satisfactory explanation of the diverse phenomena encountered in the corrosion of metals. This theory pictures corrosion as a reaction similar to that occurring in the operation of an electrolytic cell, such as an ordinary electric battery. An electric current is generated, which flows between the solution and the metal, or through the solution from the more corrodible to the less corrodible metal, where two dissimilar metals are present.

Iron has a definite tendency to go into solution when placed in contact with water, and it can only enter solution by displacing some other element already present. If iron is placed in water alone then hydrogen is the element plated out, whereas if iron is placed in a solution of copper sulfate, the copper is plated out as the iron goes into solution.

In the case where hydrogen is plated out, it gathers on the surface of the iron in a thin invisible film, and tends to obstruct further reaction by forming a protective layer on the surface of the metal. Therefore, if the reaction is to continue, the hydrogen must be removed from the metal surface, and such removal is effected by the combination of the hydrogen with the dissolved oxygen in the water solution to form additional water, or by escaping as gaseous hydrogen. The rate at which corrosion will take place is then determined by the speed with which the hydrogen is removed either by combination with oxygen or by escaping as gas.

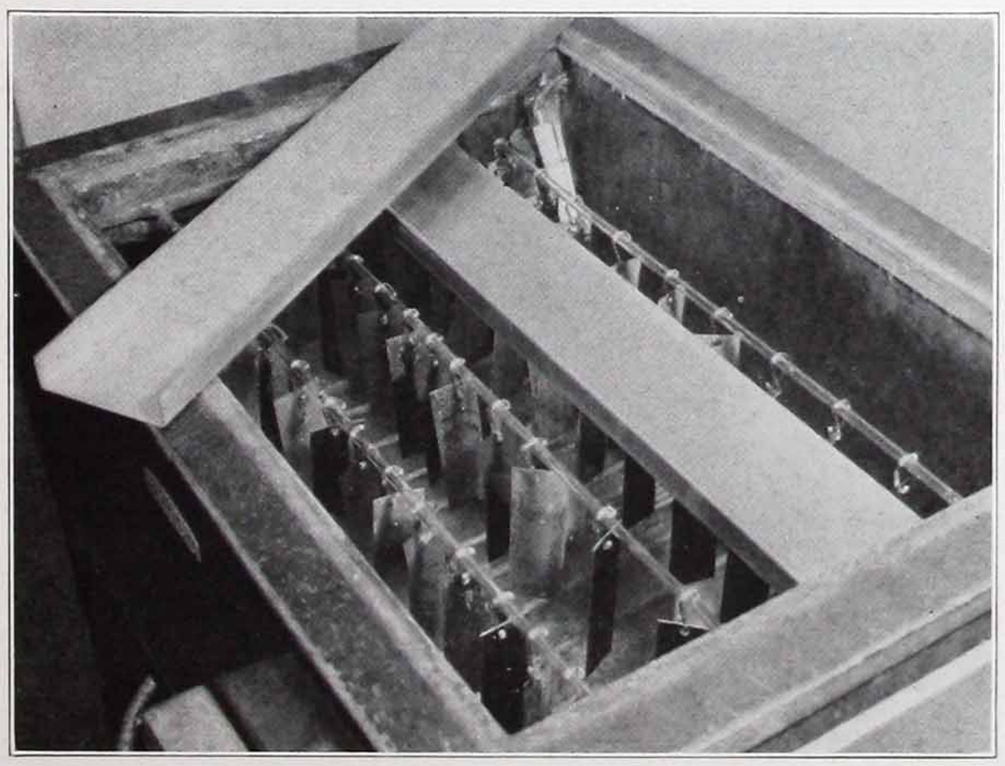

FIG. 26—Interior of humidity cabinet showing test strips in position after test; (above) protective cover used over each row to prevent moisture drippage onto test strips; (above rear) a protective cover lying on its back to reveal construction.

As previously stated, water alone has very little action on iron in the complete absence of oxygen. Therefore, the rate of corrosion is dependent upon the rate at which the dissolved oxygen reaches the metal surface, which is dependent upon several factors, namely, the rate of solution of the oxygen in the water, the concentration of the dissolved oxygen, the temperature at which the corrosion occurs, the pressure and humidity of the air above the corroding solution, the velocity of motion of the corroding solution, the presence and nature of surface films and coatings on the metal, the concentrations of other dissolved substances, and the area of the corroding solution exposed to the air.

The tendency for iron to corrode in the presence of air and water is relatively great, but the actual rate of corrosion may be small if protective films are formed or applied on the metal surface. For example, steel in a damp atmosphere is exposed to the combined action of air and moisture, and has little opportunity to build for itself a protective coating. The attack may be retarded for a time by producing a high polish on the surface, but eventually corrosion starts and proceeds as rapidly as though the surface had been initially roughened. There are, however, certain alloy steels available which resist corrosion, but generally their cost is somewhat greater than ordinary steel. Such steels are, therefore, more or less limited in their use, particularly if a corrosion resisting metal plating, of the types previously described, may prove more desirable.

CONTROL OF UNFAVORABLE CONDITIONS WHICH PROMOTE CORROSION

The surface of metal objects susceptible to corrosion should not only be protected by means of a suitable coating, but also by reducing to a mini-

mum the unfavorable external conditions which promote corrosion. The latter point is worthy of special emphasis.

HIGH HUMIDITY AND VARIABLE TEMPERATURES OF STORAGE ROOM

It is very important that the temperature and humidity of the storage room be carefully controlled. Since dry air, at normal temperatures, will not cause corrosion, it is desirable to have the relative humidity as low as practicable. An unduly high humidity accompanied by rapidly changing temperature conditions will result in appreciable precipitation of moisture on the metal in storage, thus decidedly promoting corrosion. It can readily be seen that constant-temperature, low-humidity conditions should be provided whenever possible.

The time interval between the finishing of a metal piece and the application of a protective coating must be as short as possible. This is particularly true during the spring and early summer months when the humidity is excessively high, and shop windows are customarily open.

WATER DRIPPAGE, SPLASHING AND OUTDOOR EXPOSURE

Storage facilities should be such as to (1) prevent water from dripping onto the stored metal from overhead pipes (Fig. 27, item 3), etc.; (2) prevent splashing or spraying from nearby washing operations; and (3) whenever possible, protection from direct outdoor exposure. In the event such unfavorable conditions of storage cannot be eliminated, a rust preventive must be selected which will adequately withstand them if proper protection is to be secured.

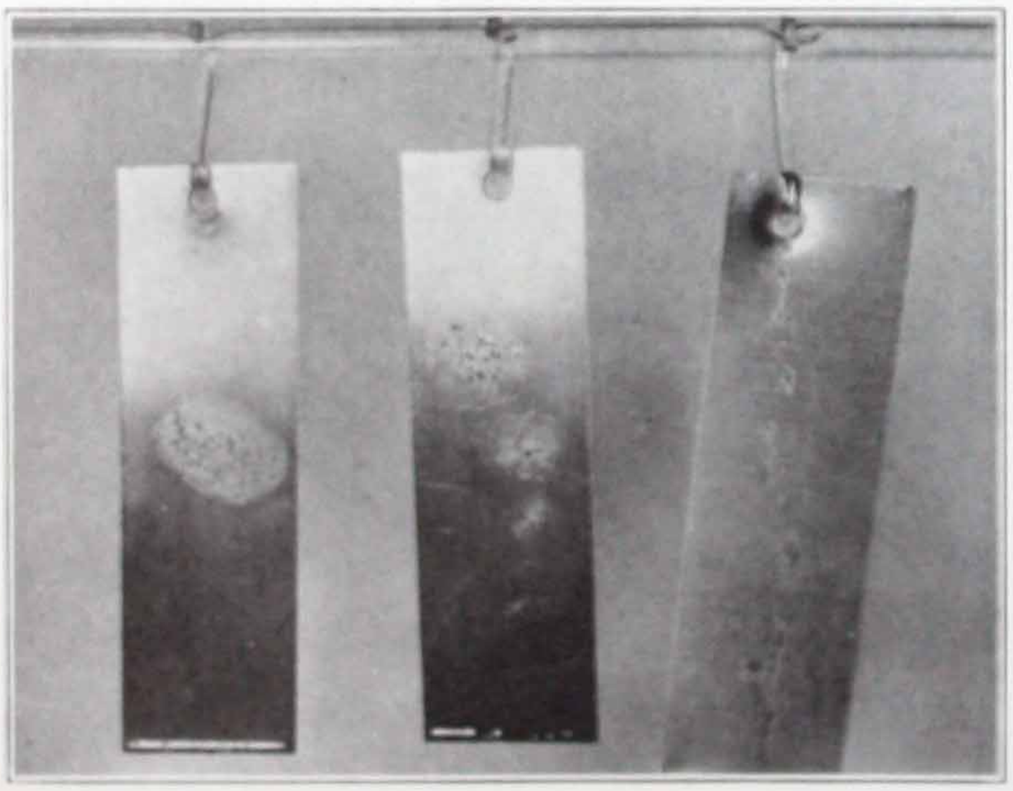

FIG. 27—(Left and Center) Examples of fingerprint corrosion resulting from handling of piece before application of rust preventive. The subsequent application of rust preventive is unable to prevent this under-corrosion. (Right) An example of corrosion resulting from drippage of water on a piece protected with a light-bodied rust preventive, not intended to meet such a condition.

FURNACE GASES AND OTHER CORROSIVE FUMES

In addition to protection from water, care should be exercised to see that the stored metal does not come in contact with furnace gases or fumes from pickling baths. Such highly corrosive gases may readily penetrate the rust preventive coating, ultimately attacking the metal and causing corrosion.

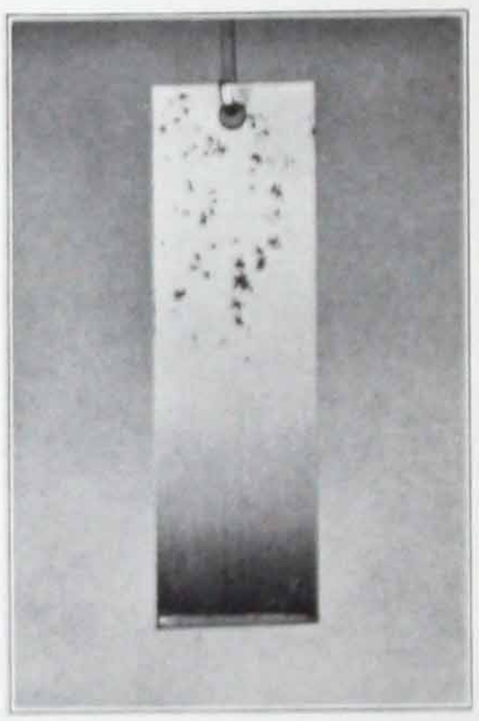

FIG. 28—An example of salt water corrosion.

CAUSTIC CLEANING BATHS

If caustic cleaning baths are employed, it is highly important that a thorough rinsing and drying follows the washing operation, otherwise staining will occur due to the presence of any caustic left on the surface.

FINGERPRINT CORROSION

It is essential to make certain that metal surfaces are thoroughly clean and dry before the application of any rust preventive, and in this connection it is very important that care be exercised to prevent finger marks from perspiration on the hands of operators. Fingerprinting is a definite source of corrosion troubles, and each mark of

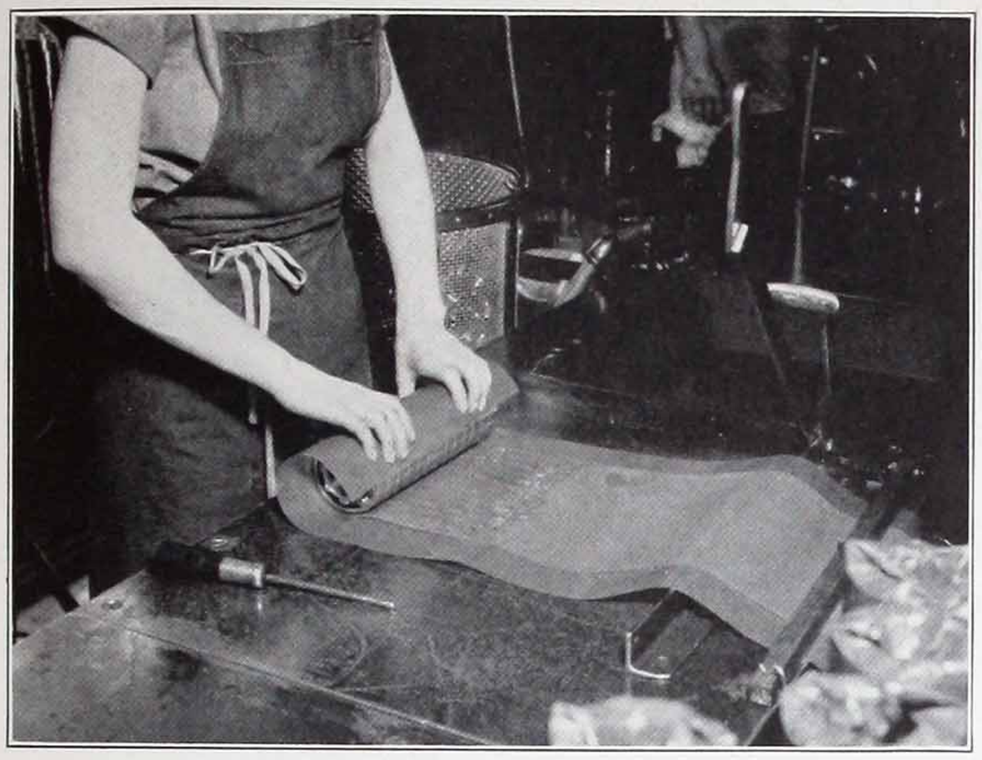

FIG. 29—Wrapping of ball bearings in oiled paper after dipping in melted rust preventive. This wrapping guards the bearings against bare hands and helps maintain the protective film.
Courtesy, International Harvester Co.

perspiration left on the metal surface forms a nucleus for the development of rusting as shown in Fig. 27, items 1 and 2. Once corrosion has started, prior to the application of a rust preventive, such application will not eliminate further development of corrosion.

ETCHING FROM ELECTROLYSIS MISTAKEN FOR RUSTING

Occasionally a slight blemish on a highly finished steel part results from electrolytic etching which may be mistaken for rust, and the rust preventive product unjustly blamed for failure to protect. This blemish, which may appear as a faint mark or spot, has been found on ball or roller bearing parts, piled together in storage before the application of a rust preventive. For reasons not yet fully explainable, a weak electric current is somehow set up between contacting surfaces that results eventually in etching. If this etching occurs before the rust preventive is applied, it may serve as a nucleus for corrosion development, like any other surface blemish, and the rust preventive is unable to overcome the handicap. There have been instances where a baffling rust preventive problem like this could not be solved until practices were adopted to minimize the possibility of electrolytic effect. In addition to ball and roller bearings, Diesel engine fuel injection equipment has occasionally been subjected to the same difficulty.

OUTSTANDING PROPERTIES OF STANORUST PRODUCTS

Among the outstanding features of the special rust preventive products known as "STANORUST" are the following:

1. They are able to give better protection, grade for grade, than other products of similar type under similar conditions.

2. They prevent rusting even under corrosive salt spray conditions, the lighter grades giving some protection under moderately severe conditions, and the heavier grades complete protection even under extremely severe conditions.

3. They can be heated for melting, or to permit more economical application, and as a consequence of heating will not foam, separate, or form tarry deposits. (Exception—Stanorust No. 5 which contains naphtha and should not be heated.)

4. All grades are relatively light in color, and the protected part will have more sales appeal than would be secured with a dark product.

5. They can be very easily applied, and grades are available for spraying, dipping and swabbing.

6. They are lubricants in addition to being rust preventives; consequently they need not be removed when the part is put in service, unless the surface is dirty.

7. When desired, they can be readily removed by wiping with a cloth wet with gasoline or kerosene.

8. The thinnest films, when properly applied, will give the desired protection without hardening and forming paint-like films which are difficult to remove.

9. They are able to expand and contract with changes in temperature, without forming cracks in the film.
10. They are non-injurious to workers.
11. They have no unpleasant odor.
12. There is a grade for every purpose.

VARIOUS GRADES OF STANORUST AND RECOMMENDED USES

The Stanorust line consists of eight regular grades, thereby providing a product to meet practically any of the wide range of conditions likely to be encountered.

STANORUST No. 00 is a light-bodied, light-colored product designed for the protection of all kinds of metal surfaces, subjected to inside storage conditions. Because of the light body of this grade, it can be applied cold very efficiently by dipping, spraying or swabbing. It will give good protection against damp conditions, but will not protect against direct exposure to the weather, as it is too light to resist the washing action of rain. It also drains rather quickly from the coated part. Furthermore, it should not be used for long-time storage where parts are exposed to dust or to handling, unless they are wrapped in waxed or oiled paper. This must be borne in mind when comparing it with rust preventives which are heavier in body and therefore better able to give protection against such adverse conditions.

STANORUST No. 0 is somewhat heavier in body than the No. 00 grade and also is light in color. It will give the greater protection required for severe inside storage conditions. Because of its heavier body it will give some protection against direct weather exposure; however, it is not primarily intended for this purpose. The product may be applied cold by dipping, spraying or swabbing.

STANORUST No. 1 is a semi-fluid product recommended for the same type of work as the No. 00 and No. 0 grades, but where better protection is required over a longer period. Its body is, however, not so heavy but that it may be sprayed at temperatures as low as 30° F. or may be applied by dipping or swabbing.

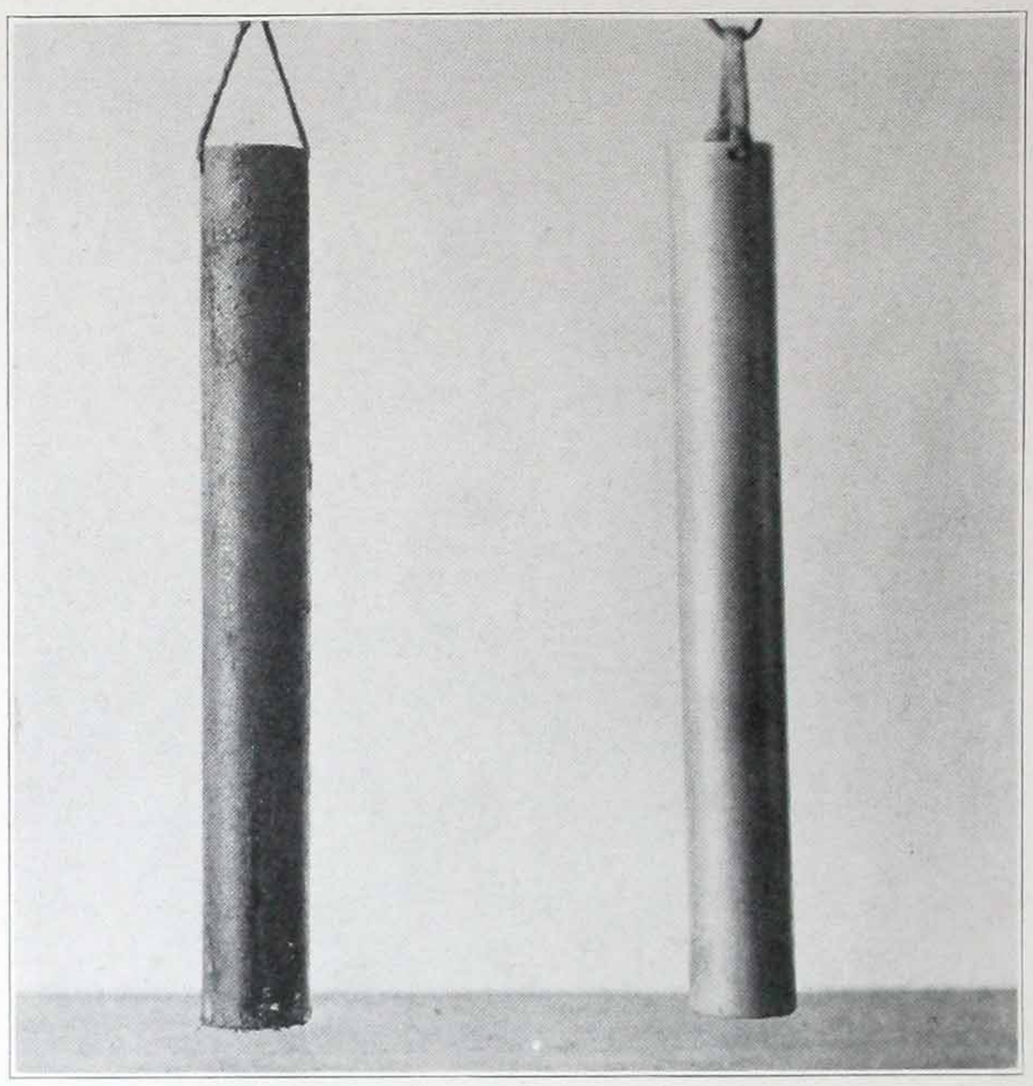

FIG. 30—Results of immersion test on two steel rods. The bright rod is protected by Stanorust No. 00.

STANORUST No. 2 is a semi-fluid product somewhat heavier than the No. 1 grade and it offers protection approximately equal to that which can be secured with the next heavier grade, No. 3, but its lighter body and consistency combined with its ease of removal make it of special appeal for use on bulky pieces. For outside storage, except under severe weather conditions, it will give surprisingly good protection for a product that can be applied by dipping, spraying or swabbing at temperatures as low as 50° F.

STANORUST No. 3 is a semi-fluid product of heavier body than grade No. 2 and has a consistency close to a No. 1 cup grease at room temperatures. For a product so heavy,it has an exceptionally light color. It is completely fluid at 100° F., and parts can be conveniently coated by dipping them in the melted product, or by swabbing. The product is soft enough at ordinary temperatures to permit

application by swabbing without heating (Fig. 8). Application may even be made by spraying at a temperature as low as 60° F., but to secure the thinnest film for most economical coverage, the product should be heated to at least 90° F. This grade is made for protecting parts against severe inside storage conditions, and to a limited extent will give good protection against the action of the weather.

This grade of STANORUST is particularly adaptable for protecting steel ball and roller bearings Fig. 31). Its light color combined with its superior rust proofing properties makes it an ideal product for supplying the extremely important protection needed for such parts.

STANORUST No. 3½ is a semi-fluid product of slightly heavier body than grade No. 3. It provides still greater protection in very thin films when applied hot, thus combining good protection and economy. It is especially well suited for hot application by dipping or spraying to ball and roller bearings. (Figs. 29 and 34.)

STANORUST No. 4 is a relatively solid, adhesive product of about a No. 4 cup grease consistency at room temperature and of exceptionally light color. It is entirely fluid at 130° F. and, of course, must be applied in the melted state. Parts or surfaces coated with thin films of this product are protected for long periods of time when exposed to the direct action of the weather, or to the corrosive action of salt and water. The film formed by dipping parts in the melted product is very stiff and wax-like after cooling, giving a surface that has little tendency to pick up dirt or to rub off. Although it is wax-like and fairly hard, it does not crack or scale. The wax-like surface is obtained only by using the product straight, i.e. in its original form. STANORUST No. 4 affords very good protection in hot, damp climates and is especially suited for export shipments (Fig. 36). At temperatures which, under unusual conditions might run slightly above its melting point, the product may drip, but always a protective coating is left upon cooling.

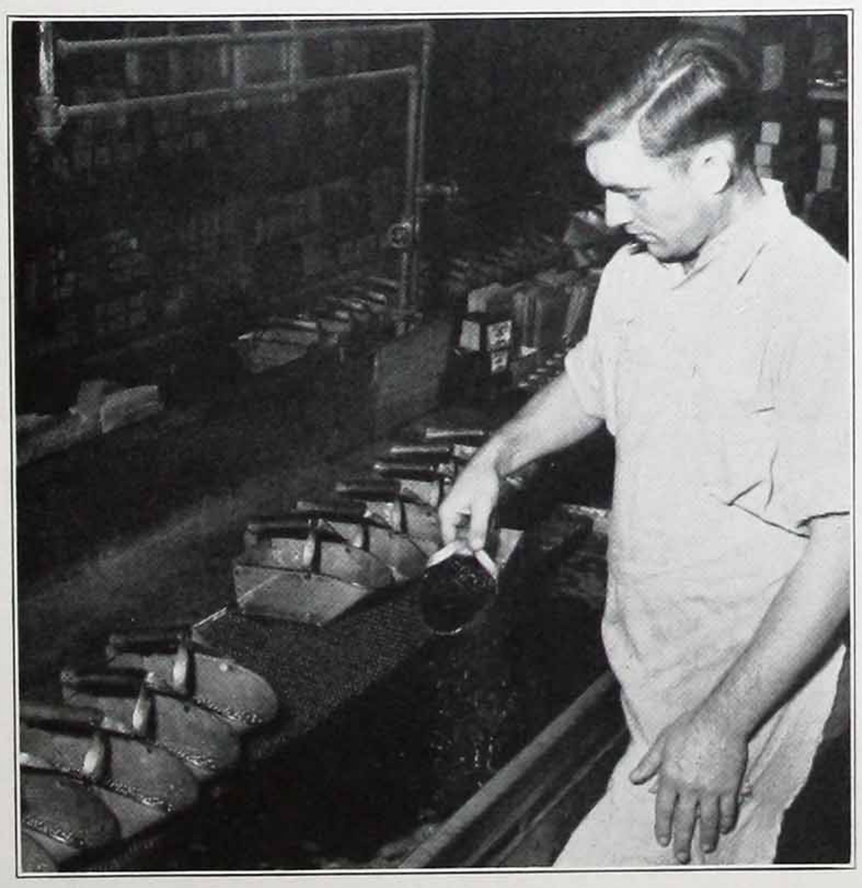

FIG. 31—Stanorust application to ball bearings by dipping. The application is made with a minimum amount of equipment and handling, and does not leave an excess of rust preventive on the bearings.

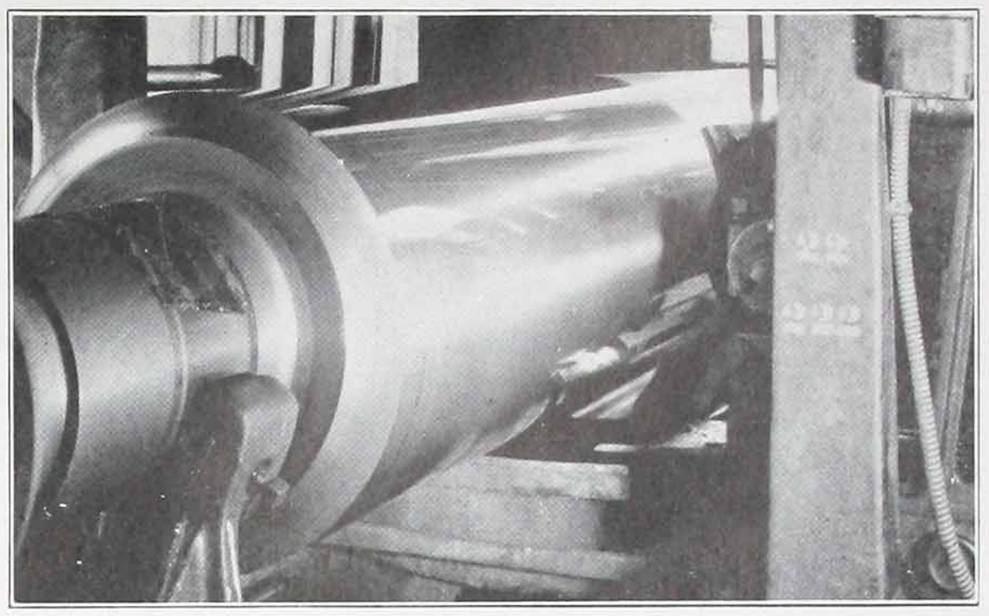

FIG. 32—Protection of paper mill rolls in storage against corrosion saves regrinding expense. Stanorust gives the protection needed and is easy to apply and remove.

STANORUST No. 5 is a semi-solid relatively light colored product having approximately a No. 1 cup grease consistency, and offers the same protective qualities as STANORUST No. 4 which it resembles except that it has been thinned with a volatile carrier to permit cold application with a swab or brush. It is particularly suited for protecting large machines and equipment (Figs. 17 and 33) which cannot be dipped readily in a product which must be melted, or swabbed economically with such a product. The volatile carrier evaporates in about eight hours, leaving a thin, tough,

FIG. 33—Large pieces of equipment and machinery used outside and frequently left standing idle are subjected to severe exposure to the weather which exacts a heavy toll in rust. Contractors, mining companies, and farmers find Stanorust No. 5 excellent for these conditions because it combines maximum protection with cold application by brushing or swabbing.

adhesive film. Because of the presence of the volatile carrier, this grade of STANORUST should not be heated for application. It can, however, be handled with the same degree of safety as heavy naphtha. STANORUST No. 5 will protect parts against direct exposure to the weather, brine or other corrosive conditions if care is taken to cover the entire surface. This is a high degree of protection for a product that can be applied without heating. Contractors, industrial plants, beet sugar plants, canneries and other users of machinery all have idle equipment at times, and STANORUST No. 5 applied after the surface to be protected has first been cleaned, is an excellent rust preventive for this class of material, because of its ease of application and its complete protective action.

STANORUST COMBINES MANY DESIRABLE PROPERTIES

Only thin films of any of the STANORUST products are needed to give protection. They give protection equivalent to that furnished by inferior products used in greater quantities, or they give superior protection when equal quantities are used. All of the STANORUST products are lubricants and need not be removed when a treated part is put in use, unless dirt and dust have collected on the parts. If the rust preventive must be removed, wiping the parts with rags or washing the parts in a kerosene bath easily accomplishes this. Unlike many rust preventives the STANORUST products

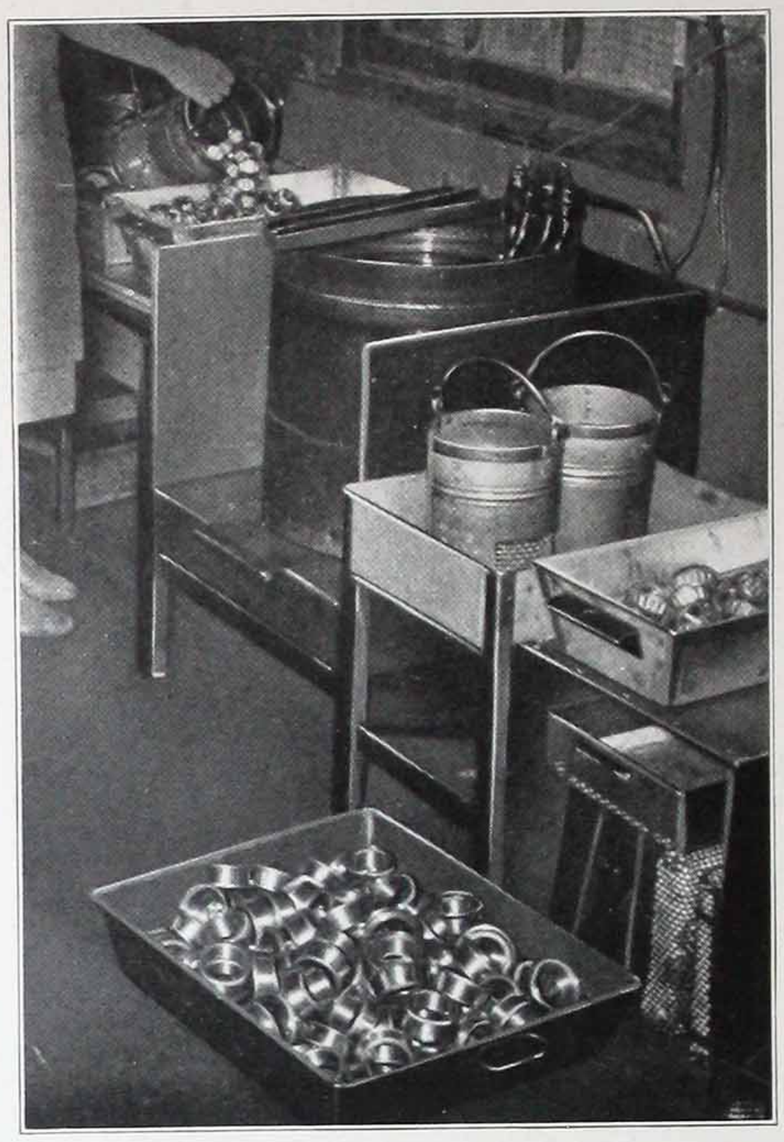

FIG. 34—Roller bearing parts being dipped in melted rust preventive to secure complete coverage with an economical film.

are stable and do not gum or harden to give paint-like films. Except for STANORUST No. 5, which contains naphtha, they may all be heated for application. They are all light in color, and when applied to equipment and parts do not give them an unsightly appearance as do many products. No unpleasant odor or skin irritation is experienced with their use. All of the STANORUST products contain special components which effectively protect against salt spray, fingerprint corrosion, and impart other important properties that provide exceptional protection under very adverse conditions.

STANORUST INSURES AGAINST HEAVY EXPENSE OF FAILURE TO PROTECT

Many manufacturers, with the commendable object of saving money, unwittingly believe that adequate rust prevention can be secured through the use of the cheapest possible products. Quite often it is not regarded by them as essential that

FIG. 35—Equipment and machinery in course of shipment requires protection of vital parts against rust. A good rust preventive is needed to keep the frictional surfaces unimpaired by corrosive attack When complete protection is not provided, premature wear and inefficient operation are likely to result.

a rust preventive be more than a very ordinary and inexpensive product, or that special preparation of the product or special ingredients in the product are required. Investigation has shown, however, that straight petroleum oils and petrolatums, and even especially prepared products, if of inferior quality, may give what appears to be good protection for a while, but a time invariably comes when an adverse condition arises and the inferior products will fail to give the protection required, and corrosion results, with an ultimate loss of material and labor which more than offsets the cost of a continuous use of superior products. One of the objects of this bulletin has been to point out that definitely superior petroleum rust preventives for overcoming these shortcomings are available in the STANORUST line of products.

FIG. 36—Export shipments are likely to encounter corrosive salt air or tropical humidity, which calls for the best possible rust protection. Climatic conditions and fluctuations in temperature are likely to be extremely adverse. Stanorust No. 5, applied cold, or Stanorust No. 4, applied hot when that is possible, are unsurpassed for supplying the needed protection without impairing the subsequent operation of mechanisms or frictional surfaces.

STANORUST HAS EXTREMELY WIDE USE

There is hardly an industry in which a profitable use for a STANORUST product cannot be found, for it is particularly suited to give protection to material and products susceptible to rusting or corrosion during manufacture, storage, shipment, or use, and it is of special service on equipment which is idle, and for equipment that must endure the rigors of export shipment.

CONCLUSION

In practically every plant, rust is a constant menace. The Standard Oil Company (Indiana), through its Industrial Engineering Service, offers the assistance needed to remove this rust menace by means of dependable methods of rust prevention based on a superior line of rust preventive products—STANORUST.